# ANNALS OF MEDICAL HISTORY

PUBLISHED QUARTERLY

Volume IX, No. 3 SEPTEMBER, 1927 Serial No. 35

*EDITOR*

FRANCIS R. PACKARD, M.D., Philadelphia, Pa.

*ASSOCIATE EDITORS*

| | |
|---|---|
| HORACE MANCHESTER BROWN, M.D. | Milwaukee |
| LEROY CRUMMER | Omaha |
| HARVEY CUSHING, M.D. | Boston |
| CHARLES L. DANA, M.D. | New York |
| GEORGE DOCK, M.D. | Pasadena |
| FIELDING H. GARRISON, M.D. | Washington |
| HENRY BARTON JACOBS, M.D. | Baltimore |
| HOWARD A. KELLY, M.D. | Baltimore |
| ARNOLD C. KLEBS, M.D. | Nyon |
| SAMUEL W. LAMBERT, M.D. | New York |
| THOMAS McCRAE, M.D. | Philadelphia |
| LEWIS STEPHEN PILCHER, M.D. | Brooklyn |
| SIR D'ARCY POWER, K.B.E., F.R.C.S.(ENG.), F.S.A. | London |
| DAVID RIESMAN, M.D. | Philadelphia |
| SIR HUMPHRY ROLLESTON, BART., K.C.B., M.D. | Cambridge |
| JOHN RUHRÄH, M.D. | Baltimore |
| CHARLES SINGER, M.D. | Oxford |
| EDWARD C. STREETER, M.D. | Boston |
| CASEY A. WOOD, M.D. | Chicago |

## FALL NUMBER

NEW YORK
PAUL B. HOEBER, INC., PUBLISHERS
SEVENTY-SIX FIFTH AVENUE

# ANNALS OF MEDICAL HISTORY

VOLUME IX, No. 3 SEPTEMBER, 1927 SERIAL No. 35

## CONTENTS

PAGE

PORTRAIT OF ALEXANDER MUNRO, SECUNDUS . . . . . . . . . . . . . Cover

PORTRAIT OF JOSEPH LISTER . . . . . . . . . . . . . . . . . Frontispiece

THE CENTENARY OF LISTER (1827–1927): A TALE OF SEPSIS AND ANTISEPSIS . . . ASTLEY PASTON COOPER ASHHURST 205

DR. JOSEPH BUCHANAN . . . . . . . . A. H. BARKLEY . . . . . . . 222

THE MEDICAL ASPECT OF ROBERT HOOKE . WILLIAM SHAINLINE MIDDLETON . 227

THE INFLUENCE OF THE THREE MONROS ON THE PRACTICE OF MEDICINE AND SURGERY S. WILLIAM SIMON . . . . . . 244

INAUGURAL MEDICAL DEBATE ON ELEPHANTIASIS OR LEPRA ARABUM . . . . . O. E. DENNY . . . . . . . . . 267

STUDIES IN PALEOPATHOLOGY XXI. (INJURIES TO THE HEAD AMONG THE PRE-COLUMBIAN PERUVIANS) . . . . . . . . . . ROY L. MOODIE . . . . . . . 277

EDITORIAL . . . . . . . . . . . . . . . . . . . . . . . . . 308
LORD LISTER.

BOOK REVIEWS . . . . . . . . . . . . . . . . . . . . . . . 310

LEESON: LISTER AS I KNEW HIM; NEUBERGER: DIE LEHRE VON DER HEILKRAFT DER NATUR IM WANDEL DER ZEITEN; HURRY: IMHOTEP, THE VIZIER AND PHYSICIAN OF KING ZOSER AND AFTERWARDS THE EGYPTIAN GOD OF MEDICINE; GUNTHER: EARLY MEDICAL AND BIOLOGICAL SCIENCE, EXTRACTED FROM EARLY SCIENCE IN OXFORD; BISHOF: HISTORY OF CARDIOLOGY.

---

Original articles are published only with the understanding that they are contributed exclusively to the ANNALS OF MEDICAL HISTORY. Manuscripts offered for publication, books for review, and all correspondence relating to the editorial management should be addressed to the Editor, Dr. FRANCIS R. PACKARD, 302 South 19th Street, Philadelphia, Pa.

Communications regarding subscriptions, reprints, and all matters regarding the business management of the ANNALS OF MEDICAL HISTORY should be addressed to the publishers, PAUL B. HOEBER, INC., 76 Fifth Avenue, New York City.

The ANNALS OF MEDICAL HISTORY is published quarterly, the four issues comprising one volume. No advertising is carried. The subscription price is $8.00 a year. Single numbers, as far as available, $2.50 per copy. A few sets of Vols. I, II, III, IV, V, VI, VII and VIII are available in parts as published at $8.00 per volume; $10.50 per volume, bound in cloth.

Entered as second-class matter, June 2, 1917, at the Post Office, New York, N. Y., under the Act of March 3, 1879.

Copyright, 1927, by Paul B. Hoeber, Inc.

*Frontispiece*
Annals of Medical History
Fall 1927

LORD LISTER

AS PRESIDENT OF THE ROYAL SOCIETY

(*Courtesy of*
Wellcome Historical Medical Museum)

[Headband and Initial from Crooke: A Description of the Body of Man. London, 1631.]

ANNALS OF MEDICAL HISTORY
VOLUME IX FALL, 1927 NUMBER 3

# THE CENTENARY OF LISTER (1827–1927): A TALE OF SEPSIS AND ANTISEPSIS*

*By* ASTLEY PASTON COOPER ASHHURST, M.D.

PHILADELPHIA

SURGERY holds three fundamental problems: the control of hemorrhage, the prevention of pain, and the care of wounds. France, by the intrepidity of Paré, has contributed most to the problem of the control of hemorrhage; America, by the introduction of surgical anesthesia, by Morton and by Long, has done more for the prevention of pain than any nation before or since; and Britain, in the person of Joseph Lister, has shown the way along which surgeons must travel to ensure for their wounds an uninterrupted course of healing.

I ask you to journey with me backwards, into the mists and uncertainties of the past of surgery, and to observe and note what were the conditions under which surgeons worked and patients suffered before the dawn of antisepsis. It is a long journey, over rough roads: over roads obstructed by quagmires of putrefaction and morasses of phlegmon; over roads which lead through the stench of hospital gangrene, the miasms of septicemia, the fires of erysipelas, and the chills of pyemia; into the by-paths and impasses of angioleucitis; and across deserts where the shifting sands of empiricism often covered the main route, and caused surgeons to lose their way. It is a sad journey; and if there were no other prospect at its end, it were best forgotten.

There were great surgeons before Lister, just as there were brave men before Agamemnon. The best of these surgeons possessed a reasonable understanding of the normal processes of healing. They recognized that there was no dressing so suitable to be applied to a fresh wound as the opposite side of the wound from which it had just been severed. They found that in the majority of cleanly cut wounds, union "by adhesion," as it came to be known, could be thus secured if the wound was accurately but not too tightly sutured, after checking all bleeding from its surfaces, so as to prevent the collection of blood clots between its lips; for the presence of bloodclots or any other foreign substance in the depths of a wound not only prevented union by adhesion, but actually caused suppuration. They had learned that in deep wounds involving muscle it was difficult to secure union by adhesion, even though the wound had been closed promptly by sutures; because these sutures had a tendency to unite the superficial parts of the wound, but to allow its interior to gape, and in this gaping interior blood would collect, putrefaction would occur, suppuration would supervene, and the wound would break down and leave a stinking and a painful sore. It is true that some surgeons, very careful and neat in their dressings, were able to apply compresses so skillfully and to use the roller bandage so intelligently, that they could frequently succeed in keeping the deeper parts of these large wounds in contact; and that in many instances they were able to make such wounds unite by adhesion, where their less skillful or less painstaking and attentive contemporaries never could get such wounds to heal unless left wide open from the first.

---

* Read April 6, 1927, on the occasion of the Lister Centenary Celebration of the College of Physicians of Philadelphia.

Though this doctrine of adhesion of wounds appears to have been known in the very earliest days of surgery, the medieval surgeons (if surgeons they could be called) seem to have forgotten it, or to have mistrusted it. In the almost unending wars by which Europe was rent for hundreds of years after the introduction of gunpowder, the great majority of wounds seen by surgeons were frightful in extent, badly lacerated and contused; such, in truth, as could not be made to heal by adhesion even if promptly reunited by sutures. Even sabre wounds, which were frequent in those days of hand-to-hand fighting, were usually very extensive, and always more or less contused or lacerated; so that all hope of securing union in them seems to have been very quickly abandoned. Thus it was that many surgeons brought back with them into civil life a doctrine of despair; a doctrine to the effect that wounds, especially gunshot wounds, were *poisoned*, and on that account alone could never be expected to heal unless treated by some method to overcome the poison. As a consequence, in the words of the eloquent John Bell, writing one hundred years ago:

> They never allowed the lips of a wound to fall together: they filled it with dressings and acrid balsams, or distended it with tents and leaden tubes. They were ingenious in every invention to prevent its sudden healing. . . . Every wound was forced into a painful suppuration, which the surgeons of those days were careful to encourage in proportion as the wound seemed more inflamed. The quantity of matter was again an argument that the wound needed to be thoroughly purged of its foul humours. The pain of a wound and the waste of substance was very great, under their management: the cure was proportionably slow, the scar was broad and unsightly; but they comforted themselves by saying, that this method alone was sure, and consistent with the rules of art. Those few surgeons who ventured upon the cure by direct and immediate adhesion, went fearfully and timidly to work. They were in a continual apprehension of ill accidents; and having failed to comply with the canonical or regular method, having neglected to purge the wound, the patient never suffered the slightest alteration of his health, even at the distance of years, which was not imputed, either from malice or ignorance, to this sudden and improvident cure. This was the real origin of the secret dressings; and nothing can be more singular than the various inventions which surgeons, in those days, fell upon, to persuade their patients to let their wounds be easily healed, and, at the same time, protect themselves from blame.

As Bell points out, the continual protestations by LaMotte (1722) and other good surgeons, of their never having, for the sake of gain, used any tents or injections to protract a cure, suggest to our minds some very unpleasant reflections.

For while these authors enter their protest against the general conduct of other surgeons, and show their anxiety to proclaim their own innocence, we cannot but see that they point at some practices and motives of conduct which we fain would not believe. In those days, every flap of skin, instead of being reunited, was cut away; every open wound was dressed as a sore, and every deep one was plugged with a tent, lest it should heal. Tents, syndons, setons, leaden cannulas, and strong injections, were among the chief violences of ancient surgery. And no man . . . who regarded his own character went without this cruel apparatus of tents and syndons when he was to dress even a slight wound. The old surgeons never put the lips of any wound together: if it was not large and free, their rule was to dilate it, but never with the knife; with a sort of forceps they tore it open; they seldom made counter-openings to let out the matter; they never sought to put an end to the formation of pus and the waste of the fleshy parts, but encouraged the suppurations. They plugged up the orifice, in order to dilate it. They made their tents long, that they might convey acrid medicines to the very bottom of the wound. They forced the suppuration, in order to prepare it for the second stage of their process, namely, incarnation. They prevented the natural and easy flow of the matter, that they might have the satisfaction of seeing it spout out in great profusion when they withdrew their tent. They opposed their own ways to those of nature, and liked nothing which was not done by main force of surgery. . . . No wound escaped this violence; and the practice of an ancient surgeon was exactly the same with that by which beggars counterfeit sores, or rather convert accidental wounds into perpetual ulcers. The most simple wounds of the limbs were frequently tortured by the old surgeons into the form of malignant sores, running for many months; wounds of the great cavities were always distended with tents to the imminent danger of the patient: if he survived, there remained fistulas which would never heal; the sores ran more or less according to his state of health, or the season of the year; and a man wounded in the chest wore his leaden cannula for life . . . . The old surgeons thrust their tents into all wounds, both those which were in danger of healing and those also which could not heal. They thrust them into gunshot wounds, of which, if they had understood the nature, they could have been under no apprehension of their healing suddenly, since the whole course of a gunshot wound is mortified, and the parts through which the ball has passed, being effectually killed, must be thrown in sloughs.

They thrust their long tents into the neck, or even into wounds of the cheek, till the neck or head swelled monstrously. Even in compound fractures, they thrust them deep betwixt the ends of the broken bones, as if they had been afraid lest a callus should form. They introduced their tents even into the cavities of the belly and breast. They never trepanned the skull where there was inward suppuration, without thrusting a tent into the substance of the brain itself, though sometimes they were content with laying in a syndon, or slip of linen. "Often, I am sure," says LaMotte, "I have seen those who would have been very willing to have taken the help of a mallet to drive their tents into the thorax. It was from shame only that they refrained."

There arose, then, as intimated above, a school of secret healers, who attributed their powers of curing wounds, almost or entirely without suppuration, to knowledge gained "from some eastern sage, or to have found out by deep studies in philosophy and alchemy, a sympathetic, or, as they often called it, a philosophical cure of wounds." By dint of leaving the wound alone, they let it heal naturally, while they amazed the patient and his friends by applying their magic powders and sympathetic solutions to the bloody weapon which had caused the wound; or, if the original weapon could not be found, then to a similar weapon, or even to a stick drawn across the wound, or to a bloody towel which had been in contact with it. But it is to be noted well that these quacks refused to use their magical cures in the case of any wound where they could foresee suppuration; and they absolutely refused to treat gunshot wounds.

Because gunshot wounds were poisoned, it was necessary to kill the poison by pouring over them "oil of elders, scalding hot";

and the story is well known of Paré, who, in 1536, finding after a famous battle that his burning oil was used up before he had poured it into the wounds of all the patients under his care, made bold to use instead "a digestive of yolkes of egges, oyle of roses, and turpentine."

> In the night I could not sleepe in quiet, fearing some default in not cauterizing, that I should find those to whom I had not used the burning oyle, dead impoysoned; which made me rise very early to visit them, where beyond my expectation I found those to whom I had applyed my digestive medicine, to feele little paine, and their wounds without inflammation or tumor, having rested reasonable well in the night: the other to whom was used the sayd burning oyle, I found them feverish, with great paine and tumour about the edges of their wounds. And then I resolved with myselfe never so cruelly to burne poore men wounded with gunshot.

This same Paré it was, who about twenty years later had the courage also to abandon the use of the actual cautery in favor of the ligature for the arrest of hemorrhage in amputations. But the majority of surgeons looked upon him as an obnoxious reformer, and continued to use their burnings, their scalding oil, and their tents, syndons, setons, leaden cannulas and strong injections, lest their patients' wounds should heal too quickly. The names of certain surgeons, however, stand out conspicuous above the herd, because of their more intelligent treatment of wounds.[1]

But it was not until the great reforms in surgery inaugurated by the teachings of John Hunter, in the latter part of the eighteenth century, that surgeons in general returned to simple dressings, and allowed nature to bring about healing in her own way: healing "by the first intention" of nature being rarely obtained except in small wounds, especially of the face, most clean wounds united by adhesion; while those in which adhesion could not be expected, and those in which this method failed, united by granulation and suppuration, called "the second intention."

After this happy and peaceful period of surgery, when Alanson, Hey, the Bells, and John Hunter, were the main advocates and exponents, in Great Britain, of union of wounds by adhesion, and when their teachings were being spread in this country by our own Physick, the Father of American Surgery; came the period of the Napoleonic wars, with its disruption of civil surgery, and the invasion of metropolitan hospitals by soldiers with gunshot wounds—large, ragged, and suppurating; and again there came an era of civil surgery when the experiences and teachings of military life prevailed. No surgeon dared to close his wounds or to make any attempt at union by adhesion. The patients' wounds stank and were corrupt; hospital gangrene, erysipelas, pyemia and tetanus again became dominant in every surgeon's mind, and in many a patient's wounds; scarcely any operation could be done with safety in these septic surroundings; and lying-in hospitals became veritable pest-holes, to enter which was almost equivalent to certain death. Seven times as many women died after confinement in hospitals as out of them; ovariotomy was from three to four times as fatal in general hospitals (60 to 80 per cent mortality) as in small institutions or in the patient's home (18 to 24 per cent mortality). Erichsen's figures (1874) show a frightful mortality from sepsis after amputation in all the larger British and continental hospitals: the general mortality after major amputations in civil hospitals varied from 26 to 60 per cent, while in military surgery it rose to 65 and even to 90 per cent (in the Crimean War). Of these deaths, to be sure, many were due to the shock of the original injury or to that of the operation which had not taken, but merely had *failed to save* the patient's life. But with all due allowance for such cases, pyemia alone was responsible for the death of from 12 to 30 per cent of patients counting only those who lived long enough after operation to have a chance to develop this dread disease, and without counting those additional deaths due to erysipelas, secondary hemorrhage, gangrene of the stump, "exhaustion," or "sudden sinking"—the latter terms probably indicating sepsis of some form as the cause of death.

---

[1] Fioravanti, in the early seventeenth century, possessed the knowledge of secret lotions; and after the wounds had been washed with these, and their edges apposed, he left them to heal in peace. Caesare Magati, of Ferrara, in 1616, though he followed the popular prejudice in attributing a poisonous influence to the action of the atmosphere on wound surfaces, yet wrote against tents, and opposed dressing wounds with undue frequency. Belloste, surgeon-major of the Hospital at Briançon, in the Alps, about 1700 published an excellent little book on wounds and wound treatment; and about this same time Dionis and other Paris surgeons began to take a more rational view of the care of wounds.

The cause of this prevalence of hospital diseases was thought to be overcrowding, or ineradicable infection entrenched in hospital buildings. Erichsen recommended that, in every hospital, each ward should be entirely vacated for one month every year, to permit of its cleansing and purification. Sir James Y. Simpson, of Edinburgh, became so ardently convinced of the nefarious atmosphere and hopelessly infected buildings of all large and well established hospitals, that he advocated tearing them all down and erecting in their stead cottages, widely separated from one another, for use as small hospitals; and he proposed that these cottage hospitals should be of cheap construction, so that it would be perfectly feasible to tear them all down or burn them all up every few years. Simpson found that out of 2089 amputations in hospital practice 855 died; out of 2098 amputations in country practice 226 died.

Cadge, a well-known surgeon of Norwich, wrote as follows, as late as 1874:

> I have unwillingly and almost tremblingly proceeded to operate in the hospital, but I have had a happy confidence and a perfect assurance that in all private cases I should avoid any of these disastrous consequences. . . . I come to the conclusion in my own mind that pyemia, if it does not find its birthplace, does find its natural home and resting place in hospitals; and although a hospital may not be the mother of pyemia it is its nurse.

But what was it that made these "hospital diseases" develop? All was shrouded in mystery, and most surgeons clung to the theory that the diseases were borne by the atmosphere from one patient to another: epithelial cells, dried pus, and other matters floated off in the air as a "miasm" from these infected wounds, and the impurity of the air caused the wounds of other patients to become similarly diseased because this impure air, when inhaled by the neighboring patients, thoroughly undermined their constitutions.

Erichsen, who published in 1874, an interesting series of lectures on "Hospitalism and the Causes of Death after Operations," founded his argument on the following premises: in his male accident ward in University College Hospital, London, there were 14 beds; sepsis scarcely ever occurred if no more than 7 patients in this ward had large accidental wounds or had had major amputations; but as surely as the number of such patients exceeded 9, so certainly did hospital gangrene and pyemia appear, even if one or two beds in the ward remained unoccupied. It was clear, he concluded, that the atmosphere could normally absorb, and dispose of, only a certain quantity of miasm arising from wounds; and that, when its point of saturation was reached, the wounds became infected. Erichsen wrote:

> About the contagion of erysipelas, there can be no question. . . . On Jan. 17, 1851, a case of phlegmonous erysipelas of the leg was accidentally brought into No. 1 Ward. As soon as the nature of the disease was discovered, the patient was removed to the erysipelas ward,[2] at the top of the building, having only remained in No. 1 for about two hours. At this time No. 1 Ward was perfectly healthy; but a few days

---

[2] Every hospital had to maintain a special ward for erysipelas.

afterwards a patient lying in the next bed to that into which the erysipelatous patient had been taken, and who had been operated upon for necrosis of the ilium, was seized with erysipelas. On the 22nd, I performed five operations on patients who were in this ward. Of these cases three were attacked by erysipelas on the 24th, namely, a case of necrosis of the tibia, of partial amputation of the foot, and of encysted tumour of the scalp. All these patients died. On the 24th a patient was operated on for strangulated femoral hernia. He was seized with symptoms of low peritonitis, doubtless of erysipelatous character, on the 31st, and also died.

It is a frightful picture; and it seemed a state of affairs from which there was no ready escape except to stop doing any operations. In our own city, about this date, Prof. William Gibson was in the habit of announcing every year to his classes at the Philadelphia General Hospital ("Blockley"): "This is the season of the year when erysipelas prevails in the wards; we will do no more operations until the first of March!"[3]

But how was it to be explained that trivial operations might lead to death from erysipelas, while severe compound fractures or dislocations might sometimes escape? Consider the two following case histories, one from Bell, the other from Abernethy, both dated about one hundred years ago.

John Bell narrates that a slater, having fallen from the top of a house, fortunately lighted upon his right hand, thereby saving his life, but producing a severe compound dislocation at the wrist:

> The wrist joint was entirely torn; the radius . . . was terribly shattered; the joint was burst up with such violence, that the hand hung quite on one side towards the radius, and turned as it were upon a point; the small end of the ulna, with its styloid process, projected through the wound, and the hand looked as if spitted upon this bone . . . and so violently was the hand distorted that the head of the radius was turned out at the wound, though the wound was chiefly on the opposite edge of the forearm, namely, that next the little finger; along with the radius, one of the carpal bones projected through the wound, quite separated. I cut off the end of the radius with the cutting pincers of an amputation case; I dilated the wound with the knife, and I took up one of the arteries with the needle; I snipped away the carpal bone with scissors, for it hung only by a rag of tendon and skin. I turned the hand right upon the remaining part of the fractured radius, laid the palm of the hand and the flat inside of the forearm upon a firm splint, made a stitch in the lacerated skin of the wrist, to hold it together, and finished by laying a large flat sponge upon the open part of the wound, just a little moistened in spirits, so as to make it spongy, soft, and pliant. This closed the laceration so smoothly, that almost the whole of the integument adhered; the part which failed to adhere was of no great extent. The matter from it was in small quantity and good. In three days it was plain the hand was safe, and that there would be no gangrene. In about fifteen days the swelling had subsided, the suppuration had become very good, and the parts so close it was likely the callus was beginning to form. This man was about three months under my care . . . and now he finds his hand perfectly useful and strong for work.

Compare with this admirable result of a very severe injury, the following note from Abernethy who operated successfully on a gentleman of stout make, removing from the surface of the pectoral muscle a tumor about four inches in length, and three in breadth and depth.

> [The tumor] was found to be composed of a steatomatous substance, contained in a thin capsule. . . . It was firm, and resembled cheese in its yellow colour and unctuous appearance, but it was not unctuous to the touch. The wound made in the operation soon healed, and the patient's health was restored to as good, or seemingly a better state than before the formation of this disease. He also regained his usual athletic form. But in less than three months of his recovery, two new tumors formed, one above, and the other below the cicatrix of the wound. The patient did not particularly

---

[3] This story I have from Dr. George W. Norris, on the authority of the late Dr. Andrew H. Halberstadt, of Pottsville, Pa., a graduate of the Medical Department of the University of Pennsylvania in 1853.

attend to them till they had attained a size equal to that of a large walnut. To dissect out both these tumours, and make so free a removal of parts as to render it probable that no new growth would ensue, seemed to be a very formidable operation; and, as the nature of the former tumour was known, and it was supposed that these were of the same kind, it was agreed to puncture the upper one, to express the contents, and await the event. This was done by a puncture of half an inch in length, made by an abscess lancet. The contents were exactly like those of the original tumor. Vehement erysipelatous or irritative inflammation took place, and sloughing about the diseased part: the inflammation rapidly extended to the opposite side of the thorax, and then down the integuments of the abdomen to the groin. The derangement of the constitution was as violent as the local disease, and in about a week the patient died.

This case, concluded Abernethy, showed the danger of irritating wens. Erysipelas, he held, was a disease dependent upon constitutional causes, especially a deranged condition of the gastrointestinal tract. He never even had an idea that the use of an "abscess lancet" had anything to do with the development of erysipelas.

Whether the wound should become infected or not, seemed all a matter of chance. According to Godlee:[4]

> A surgeon had to recognize that there was no security against the simplest and most successful operations being followed by dangerous or even fatal results. When he had closed the wounds, "he was," as Volkmann said, "like a husbandman, who, having sowed his field, waits with resignation for what the harvest may bring, and reaps it, fully conscious of his own impotence against the elemental powers, which may pour down on him rain, hurricane, and hailstorm." . . .

Into this welter of wounds and sepsis came Joseph Lister, as a London medical student, in 1848. He was the fourth child, and second son of Joseph Jackson Lister, who, like his father before him, was a successful wine merchant, and a member of the Society of Friends (Quakers). Joseph Jackson Lister was in many respects a remarkable man: though largely self taught, he found time, while actively engaged in business, to indulge, as an avocation, his love of mathematics, gaining "a world wide reputation for his discoveries in the field of optics, which led to the production of the 'achromatic lens' and the perfection of the modern microscope. . . . This work gained for him the Fellowship of the Royal Society in 1832." (Godlee.)

Joseph Lister had been carefully educated under his father's supervision, though his early determination to become a surgeon was not entirely approved. He secured the degree of B.A. from University College, London, before beginning his medical studies, which he pursued in the medical school and hospital of his Alma Mater. In University College Hospital he became house surgeon under Erichsen, whose studies of hospitalism I have already quoted, and who was at that time one of the leading surgeons in London. Though the use of anesthetics in surgical operations was well established at this time, Lister, in December, 1846, had been present at the first operation performed in London under ether, by Robert Liston, at University College Hospital. The older surgeons continued their habit of rapid operating, displaying great manual dexterity and phenomenal strength, but without the niceties and neatness which were to characterize the technique of the rising generation of surgeons, for whom absence of pain on the part of their patients made hurry unnecessary. The contemporaries and immediate pupils of John Hunter had passed with the last generation—Home and Cline, Astley Cooper and Abernethy, Blizard and Wardrop. Charles Bell and Robert Liston, two of those Scottish surgeons, who, as Godlee says, had migrated to London as to a happy hunting ground, had but recently died; but Sir Benjamin Brodie, Sir James Paget, and Sir William Fergusson (also a recent arrival from Scotland) were at the height of their fame; while James Syme (who had once established himself in London but shook its dust from off his feet and retired again to Scotland because he found the professional atmosphere in London distasteful) had already made Edinburgh famous throughout the world: brilliant as operator, inspiring as teacher, beloved as Chief, he dominated by his forceful personality the entire field of British surgery; while his colleague, Sir James Y. Simpson, the patron saint of chloroform as an anesthetic, was scarcely less brilliant as a teacher and controversialist, invading all fields of medicine, but practising obstetrics and gynecology. In Paris, Dupuytren, Larrey and Lisfranc had gone, but Civiale, Maisonneuve, Velpeau, Malgaigne, and Nélaton, greatest of them all, were at the height of their reputation; while in Germany, though von Gräfe and Dieffenbach were no more, Bruns, Chelius, and Langenbeck were their worthy successors.

---

[4] Godlee, R. J. Lord Lister. Lond., 1917.

Young Lister, trained by his father in the use of the microscope, showed special interest in physiology, histology, and pathology. Those of his teachers who impressed him most were Wharton Jones, Professor of Ophthalmic Medicine and Surgery, but as much interested in physiology as in ophthalmology; and William Sharpey, the Professor of Physiology, who had been trained as a surgeon under Dupuytren, Lisfranc, and Syme, and had settled in Edinburgh where he had taught anatomy until 1836; truly a splendid training for his subsequent career in physiology. Sharpey kept in close touch with his Edinburgh friends, spending part of every summer with Syme. When Lister, who from the very first had determined to be a surgeon, had completed his studies at University College, and had received in 1852 his degree as Bachelor of Medicine from the University of London, and had been made a Fellow of the Royal College of Surgeons; it was but natural that he should adopt Sharpey's suggestion of spending a month in Edinburgh to observe Syme's practice, before making a tour of the continent and finally establishing himself in practice in London. Little did any of them think that his month of observation was to be lengthened to a residence of seven years in Edinburgh, followed by a period of nine years in Glasgow, and a second residence of eight years in Edinburgh, before he returned to settle in London in 1877, after an absence of twenty five years.

When Lister reached Edinburgh, he found much to surprise and to captivate him: he found 200 *surgical* beds in the Infirmary, while at University College Hospital there had been no more than 60; but more charming, surprising, fascinating, and incomparable yet, was Syme then in the zenith of his career as operator and teacher—Syme, with a hot head but a warmer heart; who loved controversy but hated a sham; who was persevering and obstinate, but tenderhearted and compassionate; who was willing to rouse opposition, for he snuffed the battle from afar, and loved a fight—Syme, inspiring enthusiasm, admiration, and love!

Syme learned to love and to trust Lister, and soon the latter was appointed house surgeon to Syme. "It might have been thought," says Godlee, "beneath the dignity of a Fellow of the Royal College of Surgeons of England to take such an appointment; but Lister was amply rewarded." Indeed Syme left the conduct of the wards pretty much in Lister's hands, acting himself rather in the capacity of consulting surgeon; while Lister had, to assist him, twelve dressers, who called him "the Chief." He also busied himself in reporting Syme's lectures for the *Lancet*. In a year's time Lister became Assistant Surgeon to the Infirmary; and, after a year longer spent in courtship, he became Syme's son-in-law. But his microscopical and physiological investigations were not neglected: he found it would be his duty to lecture on the pathology of inflammation, and, deciding he did not know enough of the subject himself, he set to work to study it under the microscope in the web of a frog's foot. He was led on from this to a study of the coagulation of the blood.

While these peaceful years slipped by in Edinburgh, all England was sick at heart with the news constantly coming from the Crimean War of the dreadful condition of the wounded soldiers, and the pestilential conditions in the military hospitals, where those old, old enemies, whose attenuated forms, as Béclard expressed it, are known as angioleucitis, erysipelas and phlegmon, were rampant; and where thousands were dying of hospital diseases—hospital gangrene, secondary hemorrhages, and pyemia—where only tens and hundreds had been killed in battle.

But at Edinburgh things went peacefully on, Lister's time being spent in investigation, teaching, operating, and practice, until 1860, the post of Regius Professor of Surgery in the University of Glasgow becoming vacant, he received the appointment, at the early age of thirty-three years, after endorsements had been given by many influential friends.

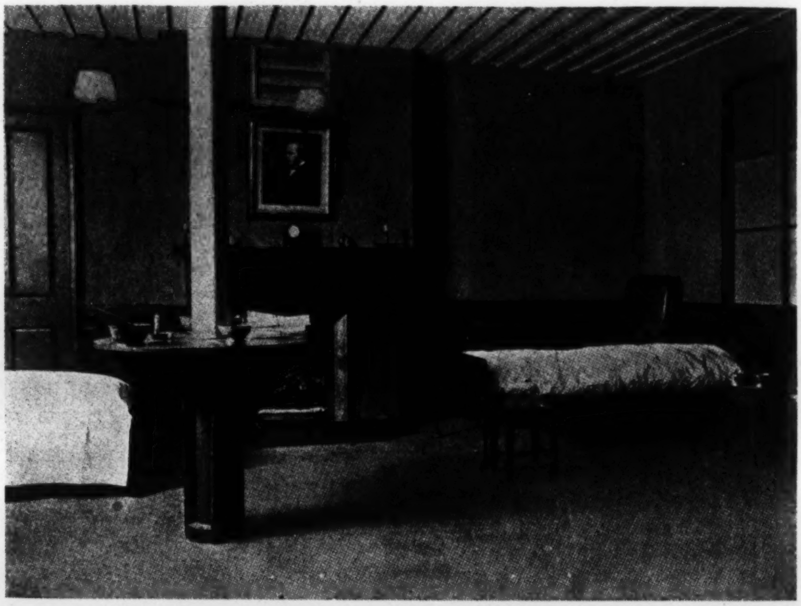
Now Glasgow was a city twice the size of Edinburgh, and the classes in the Medical School of its University were very much larger. He took the medical students by storm; they became enthusiastic; they made him Honorary President of their Medical Society. Indeed, as Mumford pointed out, Lister won through life golden opinions from those with whom he came in contact.

But the Glasgow Infirmary, to which he became surgeon, was notorious for its unhealthiness; it contained about 400 beds in all, and one operating theatre, in which about 300 operations were performed annually. The wards were overcrowded, and had often to be closed on account of the frightful mortality. Lister after his return to Edinburgh wrote of his early experiences at Glasgow:

> At this period I was engaged in a perpetual contest with the managing body, who, anxious to provide hospital accomodation for the increasing population of Glasgow, for which the Infirmary was by no means adequate, were disposed to introduce additional beds beyond those contemplated in the original construction. It is, I believe, fairly attributable to the firmness of my resistance in this matter that, though my patients suffered from the ills alluded to in a way that was sickening and often heart-rending, so as to make me sometimes feel it a questionable privilege to be connected with the institution, yet none of my wards ever assumed the frightful condition which sometimes showed itself in other parts of the building, making it necessary to shut them up entirely for a time.

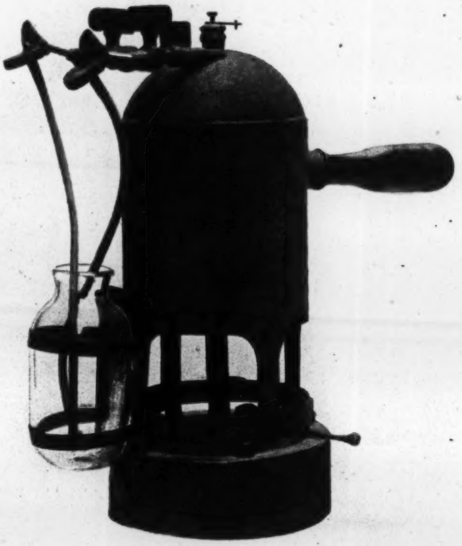
Syme's wards at Edinburgh were comparatively healthy; and he had the proud record of twenty amputations of the thigh for disease, without a death; and of only one death (and that from pyemia) among forty cases of ligation of the femoral artery for popliteal aneurysm. But he had once said to Lister that he thought perhaps it would be well if immediate amputation were done in every case of compound fracture, since on the whole the mortality would be less than if an effort were made to save some of the limbs. And in Lister's own wards at Glasgow, compound fractures did so badly, that, as noted above, he was often sick at heart. He became convinced that it was not the air alone that was poisonous to these wounds, or rather, as others before him also had suggested, that it was not at any rate the oxygen in the air that caused the wounds to become infected. He remembered the teaching of John Hunter, that if a compound fracture could be made to heal under a scab it would do as well as a simple fracture: and yet the only obvious difference between the two was that a compound fracture was open to the air, while a simple fracture was not.

Semmelweis, the Hungarian obstetrician practising in Vienna before the middle of the last century, had made an important observation, and had acted upon it with heaven-inspired empiricism: in one division of the lying-in hospital, where he was assistant, male students attended; in the other division, only midwives. In the division visited by the male students the mortality from "puerperal fever" was about three times higher than in the other division. Semmelweis, as ardent in pathology as in practice, observed in the post-mortem examination of the body of one of his colleagues, who had died of septicemia following a wound acquired at autopsy, that the lesions were precisely those which he had been in the habit of finding in the cases of puerperal fever. The truth flashed across him that the medical students, coming from post-mortem examinations, were infecting the patients in the wards by their examinations. He then insisted that the students purify their hands in solutions of chloride of lime. The result was an immediate drop in the mortality, much below that of the other division. But Semmelweis was as the voice of one crying in the wilderness: he was ridiculed, persecuted, even driven out of Vienna. Returning to Buda-Pesth in 1850, with his sensitive nature crushed by this contumely, he could not be induced to publish his views in book form until 1861, after repeated solicitation by a few firm friends and believers—notably Rokitanski, Skoda, and Hebra. But he was attacked afresh by his opponents: he was called "der Pesther Narr," and even Virchow sneered at him as "der Kerl der speculiert." Finally his mind gave way, and in 1865 he was brought back to Vienna to be put in restraint. By the irony of fate he died a few days later "of blood poisoning following a wound in his finger inflicted in the course of his professional work." (Godlee.)



Section of the Lister Ward, Wellcome Historical Medical Museum. From the Glasgow Royal Infirmary. (Courtesy of Wellcome Historical Medical Museum.)

Lister, who was not a great reader, and who was unfamiliar with the continental literature, had never heard of Semmelweis at this period when he was worrying about his compound fractures in the Glasgow Infirmary. Lister's colleague, however, Dr. Thomas Anderson, the Professor of Chemistry, called his attention in 1865 to the work of Pasteur, who had shown that "the air was full of living germs, and that these are carried on particles of dust floating in the atmosphere; that the activity of these particles of dust can be destroyed by heat, that they can be filtered off by cotton wool, or intercepted in the finely drawn-out, or tortuous necks of flasks, through which free ingress and egress of air take place owing to the diurnal variations in temperature." (Godlee.) Pasteur further had shown that fermentation was caused by certain minute germs, that putrefaction was a species of fermentation, and that both might be prevented from occurring in fermentable or putrescible substances if the latter were kept free from these impurities of the atmosphere. At once it occurred to Lister that decomposition in wounds could be prevented, without excluding the air, "by applying as a dressing some material capable of destroying the life of the floating particles." Looking around for such an agent, his attention was drawn to the means of disinfecting by means of carbolic acid (recently introduced into commerce) the sewage of the town of Carlisle, which had proved singularly successful. So Lister applied lint soaked in carbolic acid to some cases of compound fracture: in the cases with only a small external wound healing was usually uneventful; but in those with larger wounds, where more carbolic acid was used, though few of the phenomena of inflammation developed, yet a discharge of pus occurred. This pus, he soon realized, was a new kind of pus, being the effect of the tissue dissolution caused by the carbolic acid; it was not even the "laudable pus" which surgeons had been so pleased to see as an evidence that the patient's tissues were reacting well to the injury, knowing as they did that when the stage of suppuration had been reached the patient had passed the dangers of early death from fulminating sepsis. This new kind of pus was an aseptic pus, but it was undesirable, as interfering with healing, when collecting beneath the carbolic scab; moreover, the carbolic acid burned the surrounding skin surfaces. So the first improvement was to reduce the strength by diluting the carbolic acid with oil; the next step was to use a putty, impregnated with carbolic acid, as an external dressing. At first he continued these antiseptic applications only until granulations commenced, returning then to the water dressings which were in common use by other surgeons. But having learned that granulating wounds, even when secured by the antiseptic early treatment, were not entirely immune to the development of hospital gangrene, he soon continued his antiseptic dressings until the wounds were almost or entirely healed. Within a year he was using a lotion of carbolic acid (1 to 40 of water) to wash the skin preparatory to operations, soaking his instruments in carbolic solution (1 to 20), and cutting his ligatures short, leaving them to be dissolved by the tissues and absorbed or discharged as the case might be; and he could record that during the last nine months not a single case of pyemia, hospital gangrene, or erysipelas had occurred in his wards.



LARGE STEAMSPRAY USED BY LISTER. (COURTESY OF WELLCOME HISTORICAL MEDICAL MUSEUM.)

But most of Lister's contemporaries did not recognize the fact that he was contending for a principle in surgery; they looked upon his innovations as nothing more than the introduction of some new form of wound dressing—and the number and variety of wound dressings already in use was legion. The "open treatment," which consisted in applying no dressings at all, leaving the wound wide open so that its discharges might have ready exit, had its partisans in Britain, as well as in America, in Germany and elsewhere; while a number of French surgeons believed in the total exclusion of the air, Jules Guérin and Maisonneuve adopting aspiration of the air from beneath the dressings after they had been applied, and Alphonse Guérin employing a huge thickness of cotton wadding totally impermeable to the air. The "simple dressing" employed by my father, than whom no one secured better wound healing in these preantiseptic days, consisted in lint saturated and kept moist with pure laudanum, the use of which he had learned from "that excellent surgeon Dr. Joseph Pancoast"; after forty-eight hours diluted alcohol was substituted and continued until the wound was nearly healed.

Their objections to Lister's methods were, above all, that they were always being changed: first it was carbolic acid; then carbolized oil; then the carbolic putty; then watery solutions; then a carbolized cerate plaster; then a "lac plaster"; then oil of eucalyptus; was there to be no end of innovations? Moreover, he never published statistics of his cases; it is true he published, at rather tedious length, individual case histories with wordy comments; but let him come out and report a series of amputations at least as good as Syme's series of twenty thigh amputations for disease without a death, a series secured without any antiseptic trouble or carbolic acid. What is more, they would contend, this man Lister really does no better than we do ourselves: we have all of us cured cases of compound fracture; we have all of us had periods of nine months or more without a death in our wards from pyemia. Why should we change our methods of dressing wounds merely because he tells us to? Such, I imagine, were the thoughts that ran through the minds of many surgeons when their attention was called to Lister and to his work; and many of them spoke their thoughts aloud, and published their opposing views in the journals.

Meanwhile, in 1870, Lister returned to Edinburgh, to succeed Syme in the chair of Clinical Surgery. There it was that he added fuel to the fire of discontent by introducing the use of the carbolic spray both during operations and whenever a wound was to be dressed. His theory was that the spray—so fine that it barely moistened a piece of slate held in its path—would kill the germs floating on the dust in the air before they had a chance to alight on the wound. The facts that the patients, and often the assistants and sometimes the surgeon, developed mild grades of carbolic acid poisoning, and passed smoky urine; that their hands became numb and chapped from working in the carbolized atmosphere; and that occasionally the spray was misdirected by the inadvertence of the assistant who manipulated it, and that it squirted carbolic acid into the eyes of the patient even when she was Queen Victoria;—these no doubt were objections, but were entirely out-weighed in Lister's mind by the supposed advantages. And the strange thing is that there were so many surgeons the world over who came to agree with him, and, blindly adopting the spray as a necessary part of the "antiseptic system," looked upon their colleagues who would not use it as hopeless old fogies. In after years Lister himself wrote as follows: "As regards the spray, I feel ashamed that I should have ever recommended it for the purpose of destroying the microbes of the air. If we watch the formation of the spray and observe how its narrow initial cone expands as it advances, with fresh portions of air continually drawn into its vortex, we see that many of the microbes in it, having only just come under its influence, cannot possibly have been deprived of their vitality." Yet he continued to use the spray in all operations and dressings from its introduction in 1870 until the year 1887.

But some surgeons were curious enough to journey to Scotland in order to see for themselves what he was doing. Among them was Lucas-Championnière, a young Paris surgeon, who came, who saw, and who was conquered, in 1868. He returned to France, and with clarion voice and trenchant pen gave to the world the first systematic account of antiseptic surgery.[5]

The German surgeons, especially Thiersch at Leipzig, Volkmann at Halle, and Nussbaum at Münich, eagerly took up the antiseptic system, as did the best of the Scandinavian surgeons; and everywhere it was the same story of wards reeking with sepsis soon converted into models of healthfulness: where no one had dared touch a scalpel to a patient, perhaps for months at a time, almost at once pyemia, erysipelas, and hospital gangrene became things of the past; secondary hemorrhages ceased to occur, and patients no longer died of exhaustion or sudden sinkings! Ernst von Bergmann, succeeding Langenbeck at Berlin, in 1882, had the acuteness of vision to perceive that antiseptic surgery was only a transition stage; and that what Lister really had in mind, as an ideal, was aseptic technique. With characteristic German thoroughness he set himself to develop means for securing this end; and with palatial operating amphitheatres, limitless supplies of sterile gowns and dressings, and just enough antiseptics to sterilize the skin of patient and of surgeons, he showed that in most operations healing of wounds can be secured without infection, and without the contact of antiseptics with the open wound. About the same period Terrier was creating a revolution in hospitalization in France, and was teaching by precept and example the highest type of aseptic surgery.

In 1875–76 Lister made a tour of inspection on the continent, to see for himself the workings of antiseptic surgery in the hands of others; and in 1876 he came to this country in order to attend the meeting in Philadelphia of the International Medical Congress of whose Surgical Section he was elected President. Up to this time antiseptic surgery had made little impression on American surgeons. Nor can it be surprizing that to many it did not appeal: they were not entirely convinced of the germ theory of disease, and except in the military hospitals during the War of the Rebellion they had not had much experience with these dread hospital diseases. There were theoretical objections of another kind, also: even granting that microbes were the cause of suppuration, it had been proved that microbes could and did exist in wounds, treated by most rigorous antiseptic methods, without producing suppuration and without interfering with the clean healing of the wound. It must be remembered that the science of bacteriology was at this time not only in its infancy, it might be considered as being only in a fetal or embryonal stage of development. The existence of non-pathogenic bacteria was scarcely recognized, nor had Metchnikoff yet demonstrated (1883, 1893) the existence of "phagocytosis." Moreover, it was asserted that microbes could be carried by the blood; and if this were so, what was the use of applying antiseptics externally to protect the wound from microbes in the air, while nothing could be done about those brought to the wound by the blood? There were also those who based their scepticism on more practical grounds: they pointed to long series of major operations which they had done with their own hands, with a mortality which was lower by far than most of their contemporaries, and which was as low as or even lower than that secured by the devotees of antiseptic surgery in their first essays.[6]

---

[5] Chirurgie Antiseptique. Principes, modes d'application et résultats du pansement de Lister. Paris, 1880.

[6] Thus my father, who was slower almost than anyone else in adopting antiseptic principles, pointed in 1881 to the fact that for the past ten years he had not had a death from pyemia following a major amputation; and that in his first 100 major amputations there had been only 4 deaths from pyemia, none from erysipelas and none from hospital gangrene. When he compared his mortality of 4 per cent due to pyemia with Erichsen's tables, he found in the latter nearly 14 per cent of patients dying from pyemia after major amputations, or

These objections, both theoretical and practical, were hard to answer. Lister was like the man who had escaped out of Plato's cave, and had made his way up to the light: when he had seen a vision of his ideal, he came stumbling back again into the cave to tell his former fellow prisoners of the wonderful things to be seen in the land of promise. Is it any wonder, as he came back with his eyes half blinded by the light of day, that he looked to them clumsy, and awkward, and ridiculous; and that his first attempts to show others what could be done in the land of vision sometimes turned out to be failures? Lister could himself operate on seven recent cases of fracture of the patella, without a death; he could resect a femur for malunion; such operations no one could have done successfully without antiseptic surgery. But even while at Edinburgh, Lister found that such cases proved successful only when he did all the dressings with his own hands.

There came, finally, in 1877, a call for him to go to London, to succeed Sir William Fergusson as Professor of Surgery in King's College. The temptation was not as great as it would have been some years earlier. He was now fifty years of age; he was comfortably and contentedly established in Edinburgh, with a large circle of friends and acquaintances. He was at the top of the world in surgery. Students thronged to his classes; visitors from all parts of the world came to see his clinic and observe his practice. Why should he give all this up? But, up yonder was London, the world metropolis, still unbelieving in antiseptic surgery; surely he must have much to answer for, to his conscience, if he let slip this opportunity of carrying the war into the enemy's country. For Lister was deeply religious, and with a simplicity of character that made him particularly rigorous in regard to what he considered his duty: here, in Edinburgh, was comfort and content; there, in London, was the unregenerate race of surgeons. Was it not his duty to go? Can

---

nearly 4 deaths from pyemia to every 1 due to the shock of the injury or the operation.

He could point also to a series of 46 cases of excision of the knee, done without antiseptic precautions, with only 4 deaths (2 from pneumonia, 1 from bed sores, and 1 from secondary hemorrhage); a death rate of 8.6 per cent; compared to a death rate of from 24 to 30 per cent from the same operation in collective statistics, which always show too favorable results. He noted that Ollier, the great bone surgeon of France, having secured only one operative recovery among seven cases of excision of the knee (a mortality of 85 per cent), had abandoned the operation until the advent of antiseptic surgery encouraged him to adopt it once more: even then Ollier found his mortality (up to 1883) was 33 per cent; while with continued and probably more rigorous antisepsis Ollier reported that among 41 patients whose knees he excised between 1885 and 1891 his mortality was 7.5 per cent—or only 1 per cent less than my father's death rate without antiseptic methods. It is true that my father was extremely cleanly and neat in his work, and that he used laudanum, alcohol, potassium permanganate and other antiseptics long before finally adopting the "antiseptic system" as it had come to be modified by all sensible surgeons (Lister included) in the late eighties. Six years later my father wrote: "I feel compelled to say that while I cannot subscribe to the extravagant laudations which this plan receives at the hands of its more enthusiastic advocates, I believe that, when used with judgment, and, if I may be pardoned the expression, when *diluted with common sense,* it is capable of affording very valuable aid to the surgeon. I have not, indeed, found any marked diminution in the mortality after operations by its employment, but I find that the average period of convalescence is shortened; that the violence of the traumatic fever and the frequency of secondary fever are both lessened; that upon the whole the comfort of the patient is promoted; and that the labor and anxiety of the surgeon are very materially diminished. For all of which I am duly thankful."

That the antiseptic treatment of wounds was not always successful in these early days is evidenced by a story well known in the University Hospital at that time. A colleague asked my father's ward surgeon, "How many infected wounds have you on your side of the ward this morning?" And received the unexpected reply, "Just thirteen less than there are on your side the ward!"

Halsted, at the Johns Hopkins Hospital, had, about this period, suppuration in from 7 to 10 per cent of his hernia operations, in spite of careful aseptic precautions.

we not hear the still, small voice of conscience asking him, time and again, "Watchman, what of the night? Watchman, what of the night?" Was it not his duty to carry antiseptic surgery into that night of indifference and too willing ignorance? Must not his conscience have asked:

> Watchman, shall its beams alone
> Gild the land that gave it birth?

and can we not hear the answer:

> Ah, no! Ages are its own—
> Lo it bursts o'er all the earth!

And so Lister went up to London, back into that welter of wounds and sepsis, determined to show the London surgeons what a thing this antiseptic surgery was. Whether they should hear, or whether they should forbear, he was determined. "For," he must have said, "Woe unto me, if I preach not the Gospel."

And yet, his arrival in London created scarcely a ripple in the stagnant pool of professional self-esteem in which the London surgeons were steeped. He found King's College Hospital small, compared to the Royal Infirmary at Edinburgh; the students were not the same enthusiastic young men who had crowded his courses in Scotland; they rather looked askance at his teaching and practice, which they knew were not in favor at the Royal College of Surgeons. But amidst all these discouragements he kept resolutely at work, and his contemporaries finally grew used to him. With Watson Cheyne as his able lieutenant, he slowly, but surely and progressively won over the rising generation. His own contemporaries were courteous and friendly, but their surgical habits were fixed; and it remained for the next generation to carry the leaven of antisepsis with them into other metropolitan hospitals, and down into the provinces.

From about the year 1890 onward, aseptic, as distinguished from antiseptic surgery came to the fore; and though it is said Lister looked with regret on this innovation, with its parade of sterile gowns and linen, its autoclaves, its steam sterilizers, and its marble operating rooms, yet it has proved its right to an honored place in modern surgical technique.

When Lister was about to operate, he first placed the marine sponges and the instruments in carbolic solutions, took off his coat, rolled up his shirt sleeves, pinned an unsterilized towel over his waistcoat, to keep it clean, and dipped his fingers in carbolic lotion. Then, while the patient was being put under the influence of chloroform, he swabbed the part to be operated on with carbolic lotion, turned on the spray, and was ready to begin. After abandoning the spray, he always surrounded the operative area with towels wrung out of carbolic solution.

> During the operation, which was seldom short, for Lister was a slow operator, the hands of everyone concerned were frequently dipped in 1 to 40 lotion. The sponges, when soiled, were washed in cold and hot water and replaced in the 1 to 40 lotion. Thus, although they were forcibly wrung out before being used again, a small amount of carbolic acid was constantly conveyed to the wound; and, as a safeguard against any gross contamination owing to the carelessness of assistants or nurses, he used to wash the wound with 1 to 40 lotion before sewing it up. (Godlee.)

For ligatures he used specially prepared catgut, brought dry to the operation, and simply soaked for about half an hour in 1 to 20 lotion. The sutures (silver wire, silkworm gut, or sometimes fine silk or catgut) were prepared only by means of carbolic acid. The dressing in later years was a thick pad of gauze prepared with the double cyanide of mercury and zinc: the incision itself was protected from this irritating chemical by the "green protective" (oiled silk covered with copal varnish) which was dipped in carbolic lotion just before its application; the deeper layers of cyanide gauze were freshly wrung out of 1 to 40 lotion. "in order to prevent the discharge from soaking straight through opposite the wound, and in order to force it to travel to the edge of the dressing before it could be contaminated by germs, a layer of thin mackintosh cloth was placed" between the outer layers of the gauze dressing. All his wounds were drained, as the use of strong antiseptic solutions provoked considerable discharge.

As late as 1905 I saw precisely this method of operating (with the exception of the spray) still in use by two of Lister's most earnest admirers: Annandale in Edinburgh, and Lucas-Championnière in Paris.

What a contrast to the modern aseptic methods of operating: here the instruments, dressings, etc., are sterilized,[7] the former by boiling, the latter by dry heat, and the instruments are laid on a table covered with sterile sheets. The surgeon and his assistants, in white operating suits, and with cap and mask, scrub their hands in soap and water for ten minutes by the clock; they then rinse them well in alcohol, and don sterile gowns and gloves. The patient's skin, similarly prepared twenty-four hours in advance, and kept covered with sterile dressings, is painted early on the morning of operation, and again on the operating table, with iodine or picric acid in alcohol; and the part to be operated on is suitably draped in sterile sheets and towels, only the immediate operative area being left exposed. As soon as the skin incision is made, the skin edges are clipped to sterile towels, and all skin is thus excluded from the wound. With a fresh sterile knife the surgeon proceeds, using instrumental technique as much as he can. No antiseptics whatever are used during the course of the operation: everything coming into contact with the wound is sterile, and it depends on the unceasing and seemingly pedantic precautions of the surgeon to *keep* the wound aseptic. If one mis-step is made, the aseptic has to be abandoned for the antiseptic method; and it cannot be denied that adherence to a strictly aseptic technique is much more difficult, and that many surgeons seem incapable of practising it thoroughly. The antiseptic method is applicable to all primarily septic conditions (many compound fractures, necrosis, abscesses, malignant tumors, amputations, etc.); and is valuable in a somewhat modified form in all operations where the tissues are much bruised or long exposed to the atmosphere during the course of the operation (some excisions, ununited fractures, tedious dissections, etc.). When, however, the operation is of short duration (under half an hour), or when the tissues, even during a longer operation, are not bruised or otherwise unduly injured, and especially in visceral surgery, the aseptic method is superior.

When either method is properly employed, the wound heals without noticeable inflammatory reaction, no stitch abscesses form, no discharging sinuses remain, no ligatures are slowly eliminated from its depths, no granulations persist at one end of the incision, the comfort of the patient is enhanced, and the after-treatment much simplified.

Time would fail to tell of the many departments of operative surgery which have been developed only because Lister paved the way by his teaching of the proper care of wounds. Other surgeons since his time have made perhaps temporary name and fame for themselves by introducing one or other new antiseptic. During the great German War, Mencière of Rheims, introduced, much as had Lister, various lotions, and an antiseptic putty; Rutherford Morrison originated a whole system of antiseptic treatment with his bismuth, iodoform, paraffine paste (Bipp); Dakin's solution and Eusol (Edinburgh University Solution) have each their advocates still. Lemaitre showed that early *débridement*, *excision*, and *épluchage*, followed by the free application of iodine and provision for dependent drainage, permitted most war wounds to be sutured, and that, if the patients were not transported, about 85 per cent of these wounds would heal promptly; and it was further found, if wounds so treated were left unsutured at the front in the case of patients who had to be transported, that when all wounds not involving bone were sutured promptly on arrival at the base about 85 per cent would heal without further difficulty. But all these methods are merely modifications or applications of the Antiseptic Principle in Surgery, which we owe to Joseph Lister.

---

[7] Proper bacteriologic examinations are requisite for control of the sterilization of dressings, linen, etc.

Out of the morass of phlegmon, out of the quagmire of putrefaction, back from the devious paths of angioleucitis, safely through the fires of erysipelas, up from the shifting sands of therapeutic empiricism, on to the broad firm plateau of antiseptic surgery, this great man has led the nations of the world. Let us honor forever the memory of Joseph Lister, who made straight in the desert of sepsis a highway for those who come after.

## LIST OF EXHIBITS DURING THE CELEBRATION OF THE LISTER CENTENARY BY THE COLLEGE OF PHYSICIANS OF PHILADELPHIA, APRIL 4–10, 1927

### MANUSCRIPTS

1. Letter to W. W. Keen, M.D., on vivisection dated, April 4, 1898. (Bound.) Also framed photostat reproduction.
2. Letter of thanks to W. W. Keen, M.D., dated 3 April, 1907.
3. Note to W. W. Keen, M.D.
4. Letter to Samuel Lewis, M.D., dated 30 Dec., 1874.
5. Post card to De Forest Willard, M.D.
6. Receipt for "Transactions American Surgical Association" dated, 13 Mar., 1897.
7. Receipt for "Transactions American Surgical Association" dated, 4 Feb., 1898.

### PORTRAITS

1. Photograph by Elliott & Fry, 55, Baker Street W.
2. Cabinet photograph by Barraud. 263 Oxford Street, London, W.
3. Sharpey, William. Wharton Jones, James Syme, and Louis Pasteur, the four men having the greatest influence on Lister's career.
4. Lister, Joseph. Metal plaque, original in University of Rochester, Medical School. Presented by L. R. Stagg, June, 1926.

### INSTRUMENTS

1. Case of surgical instruments used during his life by Joseph Lister. Presented to the College of Physicians by Sir Rickman Godlee. July, 1920.
2. Apparatus made by and used by Lord Lister for experiments on the lactic acid and other fermentations. See Lister's Collected papers. 1907. v. i. p. 362.
3. Lister type steam vaporizer for producing carbolic spray. Presented by W. W. Keen, M.D. (Mütter museum 2894.97.)

◆

# DR. JOSEPH BUCHANAN

*By* A. H. BARKLEY, A.B., M.D.

LEXINGTON, KY.

IN contemplating Buchanan and his contemporaries it must be remembered that the condition of the Western country at that time was not favorable to the progress of literature, science and the arts. That talent and force of character which Kentuckians have so often manifested in a brilliant manner have found their outlet in business enterprise, personal adventure, war and in forensic and political strife. The calm pursuit of letters was not the natural vocation of these men, or their immediate antecedents, yet even under these adverse conditions, Kentucky has had not only orators, soldiers and statesmen of the first rank, but artists, scholars and doctors of whom she may be justly proud. Kentucky's native sons have always been prominent. The same can be said of her adopted sons; such was the case of Dr. Joseph Buchanan, who like Ephraim McDowell and Henry Clay came to Kentucky early in life from Virginia.

Dr. Joseph Buchanan was born in Washington County, Virginia, August 24, 1785. When a mere boy of ten years of age, his parents removed to Tennessee, the trip a long and tedious one, as travel in those days was made under most adverse conditions and quite often not without considerable danger. Young Buchanan was delicate due to a pulmonary affection, but notwithstanding his physical infirmities he stood the trip well.

His early boyhood was spent on the Cumberland River in Tennessee, where he helped support the family by daily labor on a small mountain farm amid all the hardships of a frontier. His parents were quite poor and could ill afford to give him an education beyond the meager facilities the neighborhood school in those days afforded. His opportunities for acquiring knowledge being necessarily limited, he in 1802 entered a grammar school near Nashville. His first attendance here lasted five months and he applied himself so closely to his studies and made such rapid advance in all branches, that the teachers and students looked upon him as a great genius.

While making rapid progress in his grammar school studies, his mind was drawn off and absorbed in an invention of his own for the improvement of mills, which, however, further experience proved to be of no particular value.

In 1803, he again attended the school and in the short time of nine months mastered the Latin language and won distinction by his original composition.

Major William Edmondson of Tennessee, who took a great interest in him, became his guardian and friend and sent him to Transylvania College, at Lexington, Kentucky, in order that he might perfect his education. Transylvania, being at that time the leading as well as the oldest institution of learning in the West, attracted most of the students west and south of the Alleghenies, and from its portals went forth men who afterwards shone with great brilliancy and credit in their respective vocations.

Buchanan upon his arrival at Transylvania College was a rough, poorly clad, diffident country boy, much impoverished in health by a long-continued fever of pulmonary origin. It was not long, however, after his entrance in college that his wonderful mental capacity was discovered by both teachers and classmates. His proficiency in mathematics brought him conspicuously before the teacher by the discovery of an error while studying Ferguson's "Optics," that the author made in regard to the focal distances of lenses. His teacher in mathematics absolutely refused to listen to him and put him down as an upstart. The idea that a green country boy should have the audacity to question so eminent an authority as Ferguson was regarded by the professor as absurd. Buchanan, however, agreed to demonstrate on the blackboard the point in question, but was rudely refused the use of the board.

He later published a pamphlet in which he proved, beyond question, the sufficiency of gravitation for all the celestial motions, and further demonstrated the incorrectness of some of the hypotheses of the very distinguished Sir Isaac Newton.

In 1805 Buchanan began the study of medicine at Transylvania Medical School, where he at once placed himself under the guidance of Dr. Samuel Brown, who was professor of theory and practice, and who enjoyed a wide reputation in the great western country as a successful and skilful practitioner as well as a man of great learning. Buchanan remained at the Medical College under Dr. Brown about two years, during which time he made wonderful progress; feeling the need of further instruction, especially clinical, he decided to go to Philadelphia. After consulting Dr. Brown, it developed he did not have the necessary means, so in order to replenish his purse he went to Port Gibson, Mississippi, where he practiced. It was during his residence at the latter place he wrote a volume on "Fevers," which, while it defeated his first object, that of earning money, was a favorable introduction to the then distinguished Professors Barton and Rush. After practicing eight months in Port Gibson and suffering severely from climatic conditions, he went to Philadelphia. He showed his manuscript on "Fevers" to Drs. Rush and Barton, who complimented it highly as to style, ability and ingenuity and offered their services.

His means being insufficient for the completion of his medical education there, as well as for the publication of his book, he walked back to Lexington, Kentucky, in 1808, in twenty-seven days and without funds, but considerably improved in health.

Shortly after his return to Lexington from Philadelphia he had the degree of A.B. conferred on him by Transylvania College. In 1809 he was appointed to the chair of the institutes of medicine in Transylvania Medical College, a chair which, as then constituted, having to do with all the speculation, the metaphysics and the philosophy of medicine (as then believed), was admirably adapted to the character of his mind.

Buchanan was now twenty-four years of age and while not enjoying a large practice, he did have the esteem of his colleagues, and with his comprehensive knowledge of the sciences and his executive ability he was looked upon as the proper person to organize a medical school. Transylvania Medical Department, which had only a nominal existence at that time, had but one professor who gave no lectures. The trustees cooperating with Buchanan, a regular faculty was formed, and Dr. Buchanan set about preparing his lectures. The following fall was selected as the time to open the Medical Department, but for reasons best known to himself he entertained little hope of success; the trustees and faculty did not cooperate with him and the whole project was abandoned.

Failing to establish the medical school in 1812 he published his philosophical views in a volume of 336 pages under the title of "The Philosophy of Human Nature" of which a thousand copies were issued. This publication dispelled all doubt as to his ability as a profound thinker. This being the most important publication he ever issued and the one thing of which he was justly proud because of the fact that it attracted commendable criticism from the literary luminaries of his time, it is only proper that some of his philosophical views be here recorded.

As to the nature of the mind, the two views commonly held were (1) that the human mind is an independent spiritual existence that is mysteriously connected with the human body, and (2) that the mind is merely an organic state of matter such as constitutes the human brain. Buchanan held this latter view to be the rational one, and further, that the elements of matter possess active powers adequate to any celerity and subtleness of action in the human mind.

He was an ardent believer in the indestructibility of the essential qualities of matter. In the chapter on the "Nature and Preservation of Animal Life," he says: "From researches in chemical philosophy not an atom can perish or be radically changed in its constituent properties."

Without being tautological it may be said that in his chapter on "Excitability" he contended, and properly so, that vitalized matter in its most perfect form possessed an organic property called "excitability," which if long continued caused a disintegrating or disorganizing effect on the whole system.

In the next chapter, on the "Unity of Excitement and the Common Stimulants of Life," the discussion is rather abstruse, mentioning such common stimulants as heat, cold, sound and materials floating in the air, and he arrived at conclusions similar to those of Locke, Hume and Darwin.

After passing his chapter on "Association," in which he attempts to ascertain and illustrate the general nature of association, we pass to his discussion of "Ideas and their Association." Metaphysicians of antiquity held that ideas were of distinct existence, transmitted from the objects of Nature and retained in the mind. Buchanan says this opinion is erroneously attributed to Locke, and further that it is untenable and that an idea is an intellectual something, generated in the mind by its sensitive intercourse with external Nature.

In his discourse on "Temper," he says: "Temper of the mind is radically derived from the stimulations of the senses."

His last chapter is on "Volition." Metaphysical writers defined it as consisting in the exertion of an innate power or constituent faculty of the mind, denominated "will." Buchanan does not accept this definition, but would define volition as consisting in the association of a muscular action with an energetic conception of that action, and a predominating desire to perform it.

While Dr. Buchanan has expressed in his book many ideas not wholly in accord with present philosophical views, he, as Woolbridge Riley in his "American Philosophy" justly says, anticipated to a considerable degree some of the modern views, especially those of volition. Riley also gives him credit as being the "earliest native physiological psychologist."

Buchanan, besides publishing his book on "Philosophy of Human Nature," was the author of another book of 140 pages, called "Practical Grammar of the English Language." This was published in Lexington, Kentucky, in 1826. He claims for his grammar that it is "Adapted to all capacities," and divides it into three chapters containing all the general principles, critical exposition of etymology and a critical system of syntax. The last 30 pages he calls "The Whole," in which he says will be found everything necessary to a complete knowledge of English grammar. This book was extensively used in the schools of the Western country for many years, as we are informed that it went through three editions. It might be stated that as early as 1826 there had been published in Lexington more than a hundred books, but none were received with more favor than this little grammar.

Buchanan had "too many irons in the fire," and as might be expected derived little remuneration from his practice. Upon the advice of some friends, he gave up the practice of medicine in order that he might continue his literary and other work that was more agreeable to his taste, and to which reference will be made later.

He was an ardent Jeffersonian Democrat and warm supporter of Henry Clay and the "Old Court Party." He was editor of *The Palladium* at Frankfort, Kentucky, *The Western Spy and Literary Cadet* at Cincinnati and *The Focus* at Louisville. The latter paper he started in 1826 and was editor-in-chief until his death in 1829.

After his retirement from the practice of medicine, he was induced to give his attention to the study of and introduction into Kentucky of the Pestalozzian system of education. He visited Philadelphia to study this system as taught by Mr. Neef, and upon his return to Kentucky spent some years in Pestalozzian teaching. His results under the new system were vastly superior to any then in vogue. In educating his son under this system Buchanan says: "He far exceeded my most sanguine expectations, and all other students who were so taught made most rapid advance in their studies."

Buchanan was devoted to the science of education, and his views on this subject were those of a liberal and practical philosopher; independent and rational in all his digested and settled opinions, he was as far from being a visionary projector of reform and improvement, as he was far from being trammelled by arbitrary canons or antiquated customs. He was a staunch advocate of the idea that each age is improved in its practical knowledge, morals and manners in direct proportion to its education.

His indomitable mental activity caused him to give up the teaching of the new system of education and enter upon a course in law; in this he became so well versed, that in a few months he gave a course of lectures on some of the common law subjects to a class of private students.

Buchanan was an inventor, and to this he gave much of his time. One of his first inventions was a musical instrument in which tones of sweetest harmony were drawn from glasses of different chemical composition. He also originated a grand conception of the music of light, to be executed by means of harmonic colors, luminously displayed. This was a most singular invention, which further study showed had been anticipated by Darwin, Cassel and others, by which the deaf might see sounds and enjoy music by the eye as the blind may be supposed to hear colors.

His most important invention was in 1821 when he announced he had perfected an economical steam engine. He claimed that it was perfectly safe, of light construction, and that one cord of wood would sustain seven horse power for twenty-four hours. The engine was first used in Mr. Jackson's cotton factory, located at Nicholasville, Kentucky, where it gave satisfaction. It was thought that it would be applicable to water navigation by changing the boiler for spiral tubes, thus converting the engine then in use into a capillary engine. It was soon found to be impractical, due to the fact that the spiral tubes became incrusted by the impurities of the river water. He did use it to propel a land carriage, in which he rode through the streets of Louisville in the presence of an astonished crowd of spectators.

Buchanan may be said to be among the first, if not the first person in this country to construct an airship. After his capillary steam engine had proved a success in running a factory and land navigation, he conceived the idea, from the superior lightness of the engine, that it might be of use in aerial navigation. A company was formed, composed of some of the leading citizens of Lexington, who spent considerable money in aiding Dr. Buchanan in the construction of his airship. The work progressed far enough to demonstrate that this costly experiment was not practical in consequence of insuperable natural laws of which he, at that early date, knew nothing and which had not yet been demonstrated.

It cannot be claimed for Buchanan that he achieved great success in the practice of medicine or that his daily wants were always supplied by means derived from his practice. However, he did have the respect of his associates and had he concentrated his efforts on medicine alone, he no doubt would have stood in the front ranks of the profession. No man in his day was endowed with greater reasoning power or capable of taking a deeper or more philosophical view of any subject that engrossed his attention than he. He had an unconquerable love for work and a passion for original investigation, which outweighed all minor considerations, the fascinations of wealth, the pleasure of society and the temporary plaudits of his fellow-citizens.

That Buchanan was a highly educated man cannot be denied. He was a most voluminous reader, traversed the entire field of polite literature and culled with disciplined hand, both its rarest flowers and its choicest fruits, and thus at once embellished and enriched his intellect with such of its productions as were most beauteous and valuable, and most congenial to his feelings.

While he made no pretensions to oratory it is said that as an extemporaneous speaker he had few equals, as he spoke freely and always to the point and with such force as to compel one to think, that for the time at least, Nature had intentionally cast him in her happiest mould and endowed him in a moment of her most abundant prodigality.

The life of Buchanan affords an instructive moral; he was simple in his manners and tastes, very amiable, lofty in his aims, full of philosophy and philanthropy, original and ingenious, ardent and enthusiastic, yet subjecting everything to a careful analysis and critical reasoning. He might have attained the highest rank in any pursuit upon which his talents and energy had been concentrated; but cultivating his intellect to the neglect of other powers, he scorned the pursuit of wealth, abstracted himself from society, lived in continual pecuniary embarrassment, abandoned the road to wealth whenever it ceased to present intellectual attraction.

Thus he lived, comparatively indifferent to fame, and died in 1829 in Louisville, Kentucky, in his forty-fourth year, a man designed by Nature for greatness, of the rarest talents and of the most commanding character, whose moral qualities were as faultless as his intellectual constitution was vigorous and brilliant.

[From Erastus: Varia Opusculum Medica. Frankfurt, a. M., 1590.]

# THE MEDICAL ASPECT OF ROBERT HOOKE*

*By* WILLIAM S. MIDDLETON, M.D.

MADISON, WIS.

Of the subject of this sketch, the discerning Samuel Pepys inscribed in his famous Diary: "Above all Mr. Boyle was at the meeting, and above him Mr. Hooke, who is the most, and promises the least, of any man in the world that ever I saw." Pepys' observations are always entertaining and not infrequently instructive. Therefore his ranking of the comparatively obscure Hooke above Robert Boyle immediately arrests the attention to the basis for such a high opinion from a contemporary and competent judge.

Man is essentially the product of circumstance, and environment plays the important rôle in the careers of all except those gifted with the "divine fire." The atmosphere for advancement in the natural sciences developed slowly in Great Britain. As early as 1616 Edmund Bolton had endeavored to obtain the support of James I in the establishment of a royal academy to be termed "King James His Academe or College of Honour." In its proposed membership were to be three orders, the tutelaires (including the Knights of the Garter, Lord Chancellor and the Chancellors of the Universities), the auxiliaries (including the flower of nobility, councils of war and new plantations), and lastly the essentials (including the most able laymen, but excluding the professions and arts, since these groups were organized into independent societies). James I died in March, 1625 before this plan could be consummated. During the reign of Charles I an academy for the training of the young nobility was authorized under privy seal. Musaeum Minervae was to be erected in Covent Garden, parish of St. Martin-in-the-Fields, County of Middlesex. The duplicity of the king led to his execution in 1649 before the completion of the Museum. The period of the protectorate of Cromwell was too turbulent for constructive progress in science and education. However, for a considerable period Robert Boyle and kindred spirits among the philosophers had been carrying forward the precepts of Francis Bacon in unorganized meetings at Gresham College. Boyle referred to their group as the "Invisible College." The régime of the profligate Charles II would seem an inauspicious period for the institution of a scientific organization under royal charter. Yet the king found sufficient leisure from his intrigues and irregular amours to sanction the Royal Society. To this distinguished body he gave a mace of silver, on whose head were engraved among other devices the symbolic rose, harp, thistle, and fleur-de-lis. This token of esteem is still in the possession of the Royal Society. The first official record of the Society bears the date of November 28, 1660, and Sir Robert Moray, Lord Brouncker and Dr. Ward are considered its founders.

The object of the Royal Society was lofty: "To improve the knowledge of naturall things, and all useful Arts, Manufactures, Mechanick practices, Engynes and Inventions by Experiments—(not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick, or Logick)." Indeed their limitations were as noteworthy as their purposes. The strictures placed upon the acceptance of ill-founded theories was voiced as follows:

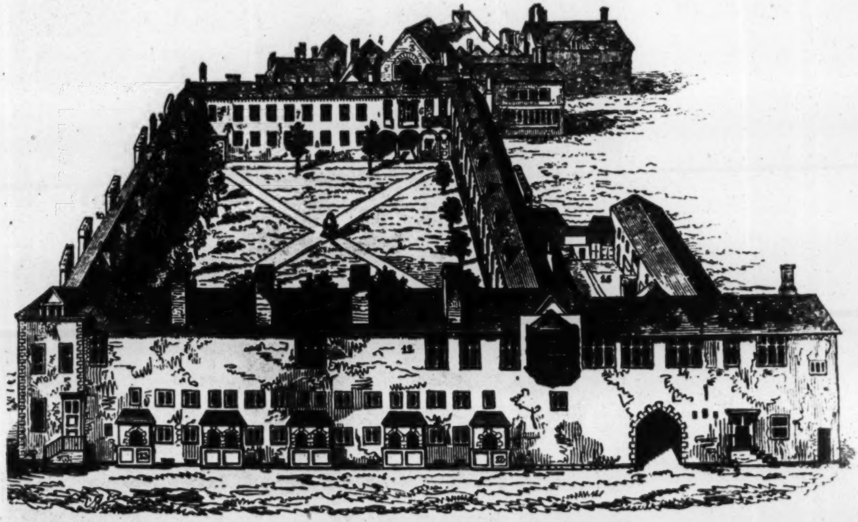
> In the mean time this Society will not own any hypothesis, system, or doctrine of the principles of naturall philosophy, proposed or mentioned by any philosopher ancient or modern, nor the explication of any phenomena whose

---

* Read before the University of Wisconsin Medical History Seminar.

recourse must be had to originall causes (as not being explicable by heat, cold, weight, figure, and the like, as effects produced thereby); nor dogmatically define, nor fix axioms of scientificall things, but will question and canvass all opinions, adopting nor adhering to none, till by mature debate and clear arguments, chiefly such as are deduced from legitimate experiments, the truth of such experiments be demonstrated invincibly.

The meeting place of the Royal Society continued in Gresham College, where had gathered the Invisible College prior to its incorporation. The early history of the Royal Society and the scientific life of Robert Hooke are indissolubly bound up with the foundation and fortunes of Gresham College. In 1575 Sir John Gresham willed that the income of a portion of the buildings of the Royal Exchange should be used for the support of four lecturers or professors, in divinity, astronomy, music and geometry. By a further grant were established lectureships in law, physic and rhetoric. The public notice of Gresham's purpose evoked the prophetic protest from his alma mater, Cambridge, that "if you design your institution to last, you will place it here." After several futile efforts to replace the dilapidated buildings of the College which had lost popular esteem after the cessation of the Royal Society meetings under its roof in 1710, legislature finally in 1767 authorized the razing of this venerable institution to make way for the excise office. For a paltry grant of five hundred pounds a year the Trustees of the College, probably illegally, agreed to demolish the buildings and to part with the valuable land they occupied.



Gresham College.

Thus was this venerable seat of learning and science, founded by the munificence of one of your most eminent citizens, and hallowed by a thousand interesting associations,—the mansion in which successive monarchs had been entertained, in which princes had lodged and banqueted,—which, when London lay in ashes, had afforded shelter and refuge to its citizens, a residence to its chief magistrate, an Exchange for its merchants, and a home to the houseless; thus was the hall in which Barrow, Briggs, Bull and Wren had lectured, and the rooms where Newton, Locke, Petty, Boyle, Hooke and Evelyn associated for the advancement of science,—razed to the ground.

To have attained the high estate of a fellowship in the Royal Society at twenty-seven years of age, Robert Hooke must have been an able man and one of unusual promise. His origin and early training are interesting. His father, John Hooke, a scholarly individual, was rector in the parish of Freshwater, Isle of Wight. Here Robert Hooke was born on Saturday, July 18, 1635, at noonday and the succeeding Sunday, July 26, was christened by his father. For the first seven years, Robert's life was despaired of by his parents. His weakly constitution for that period necessitated an extremely limited dietary of fruit and milk. Meats in particular were eschewed. Under this regimen he thrived but was forced to avoid the more vigorous games of boyhood. This physical handicap encouraged the pedantic father in the hope that Robert would find his career in the ministry and accordingly he outlined the boy's instruction. Apparently a certain facility in learning was evinced by Robert; but when persistent headaches interfered with his study, the infirm father gave up the task and the son drifted into the practice of imitating the various craftsmen. His mechanical skill and ingenuity soon became apparent. A wooden clock was modelled after a dismantled brass one. A most intriguing ship was made by him—"about a Yard long, fitly shaping it, adding its Rigging of Ropes, Pullies, masts etc. with a contrivance to make it fire off some small Guns, as it was Sailing a Haven of a pretty breadth." The father saw an outlet for the boy's natural talent in watchmaking or some similar light occupation. The boyhood of our subject was not untouched by the turmoil of the court; for to the nearby Carisbrooke Castle came the ill-fated Charles I for a short period previous to his execution.

The death of his father after a period of invalidism of three or four years left Robert on his own resources with a meager patrimony of one hundred pounds. His ability in drawing led to his early attachment to the famous artist, Sir Peter Lely. The odor of paints and oils disagreed, "increasing his Head-ach, to which he was ever too much subject." Thereafter he became house-pupil to Dr. Busby, Master of Westminster School, under whom he acquired an excellent knowledge of Greek and Latin and a less proficient acquaintance with Hebrew. Under the stimulating influence of Dr. Busby, Hooke became interested in mathematics. It is recorded that he mastered six books of Euclid in one week. In 1653, being an impecunious student, Hooke entered Christ Church, Oxford, as servitor to a Mr. Goodman.

While at Oxford Hooke's mechanical skill attracted the attention of Thomas Willis, by whom he was engaged as an assistant in chemistry. So it came to pass that when Robert Boyle sought aid in the construction of the air-pump, Hooke was recommended to him by Willis. In fragmentary notes which Hooke had hoped to shape into memoirs, the following was written: "In 1658, or 9, I contriv'd and perfected the Air-pump for Mr. Boyle, having first seen a Contrivance for that purpose made for the same honourable Person by Mr. Gratorix, which was too gross to perform any great matter." The completion of this task necessitated several journeys to London for parts not to be had at Oxford and doubtless the opportunity was afforded for contacts with the philosophical group in the metropolis, for they were a gregarious order.

Meanwhile his mind and hands were busy on his own problems:

> The same Year I contriv'd and made many trials about the Art of flying in the Air, and moving very swift on the Land and Water, of which I shew'd several designs to Dr. Wilkins then warden of Wadham College, and at the same time made a Module, which by the help of Springs and Wings, rais'd and sustain'd itself in the Air; but finding by my own trials, and afterwards by Calculation, that the Muscles of a Man's Body were not sufficient to do any thing considerable of that kind, I apply'd my Mind to contrive a way to make artificial Muscles; divers designs whereof I show'd also at the same time to Dr. Wilkins, but was in many of my Trials frustrated of my expectations.

Unfortunately the time and occasion are not ripe for the consideration of the adventures of this early Darius Green. Several of Hooke's mechanical contrivances fared a better fate. For instance the anchor escapement for clocks was his invention, and fifteen years before Huygens he had utilized the method of regulating pocket watches by a spiral spring applied to the arbor of the balance. Hooke evolved the theory, "Ut tensio, sic vis," from these observations. As in so many fields his was the touch of the pathfinder and not of the settler. Not infrequently in diversified fields of science and invention he blazed the trail, only to have a more careful and less brilliant contemporary cultivate the soil and reap the harvest.

Rob: Hooke:

Signature of Robert Hooke (from the Charter Book of the Royal Society).

The academic peace of Oxford could not hold this restless, inquiring spirit. With Dr. Seth Ward, later Bishop of Salisbury, Hooke had studied astronomy. In 1656 he had communicated to Lord Brouncker and Sir Robert Moray his proposed method to determine longitude. Their enthusiastic efforts to obtain patent rights for him were ultimately rejected because he felt that his interests were inadequately protected. However, the support of such representative men as Ward, Brouncker and Moray in the Council of the Royal Society insured his election as Curator when that position became available. Before the Royal Society on November 5, 1662:

> Sir Robert Moray propos'd a Person that was willing to be entertain'd as a Curator by the Society, offering to furnish them every day when they met, with three or four considerable Experiments; which Proposition was unanimously receiv'd, Mr. Hooke being nam'd to be the Person; and accordingly the next Day of their meeting on the twelfth of November he was unanimously accepted and taken as Curator, with the Thanks of the Society order'd to Mr. Boyle for dispensing with him for their use, and order'd that Mr. Hooke should come and sit among them, and both bring in every Day three or four of his own Experiments, and take care of such others as should be recommended to him by the Society.

Hooke thereupon severed his connection with the University but received his degree of Master of Arts, September 28, 1663, on the nomination of Lord Clarendon, Chancellor of the University.

The appointment of Robert Hooke as Curator of the Royal Society worked a mutual benefit. For Hooke it widened his scientific contact and prospect and initiated a period of feverish activity in scientific and inventive contribution. He personally demonstrated several hundred experiments before the Royal Society, and "whatever apparatus he contrived for exhibiting [*sic*], it was performed with the least embarrassment, clearly and evidently." Hooke worked assiduously to preserve a high standard of scientific accomplishment before the Society.

In this period of experimental philosophy, a medical training was not deemed essential to the serious study of the mysteries of nature and life. Therefore the contributions of Leeuwenhoek, Wren and a number of other curiously minded laymen can readily be explained. The community of scientific interest was such that no sooner had Leeuwenhoek reported his findings in the new world of microscopy than the Royal Society sought first-hand information as to his methods and results. An interesting correspondence ensued on the subject of "microscopism," and Robert Hooke in his dual capacity of curator and secretary played an important rôle in this relation.

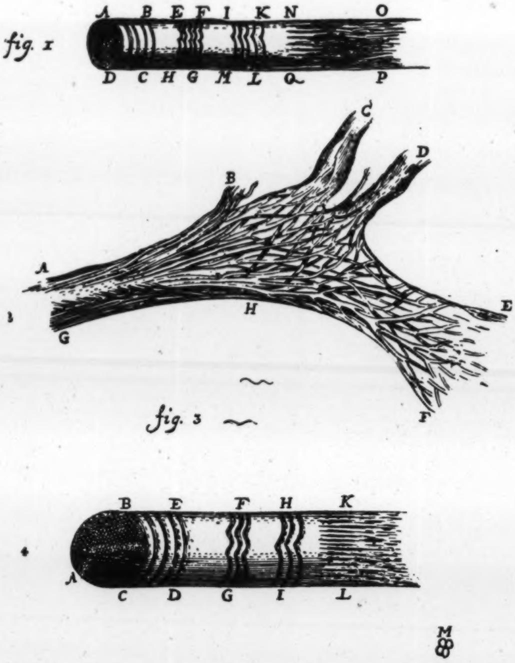
An abstract of a letter, under the date of October 5, 1677, from Leeuwenhoek to Hooke may be quoted in this connection:

> By some of my former Letters I have related what an innumerable company of little Animalcules, I have discovered in waters; of the truth of which affirmations, that I might satisfie the Illustrious Philosophers of your Society, I have here sent the Testimonials of eight credit-

> able persons; some of which affirm that they have seen 10,000, others 30,000, others 45,000 little living Creatures, in a quantity of water as big as a grain of Millet (92 of which go to the making up of the bigness of a green Pea, or the quantity of a natural drop of water) in the desiring of which Testimonials I made it my request that they would only justifie (that they might be within compass) half the number that they believed each of them saw in the water, and even so the number of those little creatures that would thereby be proved to be in one drop of water would be so great that it would exceed belief. Now whereas by Letters of the 9th of October 1676, I affirmed that there were more than 1,000,000 living Creatures contained in one drop of Pepper-water. I should not have varied from the truth of it, if I had asserted that there were 8,000,000; for if according to some of the included testimonials there might be found in a quantity of water as big as a millet seed, no less than 45,000 animalcules, It would follow that in an ordinary drop of this water there would be no less than 4,140,000 living creatures, which number if doubled will make 8,280,000 living Creatures seen in the quantity of one drop of water, which quantity I can with truth affirm I have discerned.

Here was a ripe field for the inquiring mind and the perceiving eye. The Society's sanction was scarcely necessary to set Hooke at work. Of the results of this effort the following report bears witness:

> Upon the perusal of this Letter, being extremely desirous to examine this matter farther, and to be ascertained by ocular inspection as well as from testimonials I put in order such remainders as I had of my former Microscopes (having by reason of a weakness in my sight omitted the use of them for many years) and steeped some black pepper in River water, but examining that water about two or three days after, I could not by any means discover any of those little creatures mentioned in the aforesaid Letter: though I had made use of small glass canes drawn hollow for that purpose, and of a Microscope that I was certain would discover things much smaller than such as the aforesaid Mr. Leeuwenhoek had affirmed these creatures to be; but whether it were that the light was not convenient (the reason of which I shall show by and by) having looked only against the clear sky, or that they were not yet generated which I rather suppose, I could not discover any. I concluded therefore either that my Microscope was not so good as that he made use of, or that the time of the year (which was in November) was not so fit for such generations, or else that there might be somewhat ascribed to the difference of places; as that Holland might be more proper for the production of such little creatures than England. I omitted therefore farther to look after them for about five or six days, when finding it a warm day I examined again the said water; and then much to wonder I discovered vast multitudes of those exceeding small creatures, which Mr. Leeuwenhoek had described; and upon making use of other lights and glasses, as I shall by and by show, I not only magnified those I had thus discovered to a great bigness, but I discovered many other sorts very much smaller than those I first saw, and some of these so exceeding small, that millions of millions might be contained in one drop of water. I was very much surprised at this so wonderful a spectacle, having never seen any living creature comparable to these for smallness; nor could I indeed imagine that nature had afforded instances of so exceedingly minute animal pro-



DRAWING OF MUSCLE FIBERS BY LEEUWENHOEK.

ductions. But nature is not to be limited by our narrow apprehension; further improvements of glasses may yet further enlighten our understanding, and ocular inspection may demonstrate that which as yet we may think too extravagant either to feign or suppose.

The fascinating new field opened by microscopy and its ensuing problems led to a frequent interchange of observations between the ponderous pioneer in Delft and the more brilliant but less stable experimental philosopher in London. Leeuwenhoek contributed his studies on the blood corpuscles of the eel and man, capillary circulation, muscle fibers and spermatozoa. As in his earliest communications to the Royal Society an attempt at mathematical accuracy may be remarked, such as likening the thickness of a muscle fiber to the breadth of a hair of his peruke. Robert Hooke carried this detail even further, in that he thus described the cross-section of a ligament:

> If you view the thread of a Ligament, you shall plainly see it to be made up of an infinite company of exceeding small threads small and round, lying close together; each of which threads is not above a four-hundredth part of the bigness of a hair; for comparing those of Beef with a hair of my head, which was very fine and small, viz. about a 640. part of an inch, I found the Diameter thereof to be more than twenty times the Diameter of these threads; so that no less than 163 millions, besides 840 thousands of those must be in a ligament one inch square.

As to muscles, Hooke, apparently misled by some spherical aberration, endeavored to reconcile his microscopic findings to the prevalent theory of muscle contraction. He concluded:

> The fleshy part of a muscle consisted of an infinite number of exceeding small round Pipes, extended between the two tendons of the Muscles, and seem'd to end in them. Which Tendons, in the Muscles of Beef boyl'd would be easily stript off from those Pipes very distinct and visible: He said that the reason of the moving of a Muscle might be from the filling or emptying of those Pipes, whose sides seem'd to be flexible like those of a Gut.

His old effort to solve the problem of human flying asserted itself; "He intimated also that he knew a way of making succedaneous Muscles for a Man for flying, and give one Man the strength of ten or twenty, if required." Waller further reported Hooke's conclusions of the physiology of muscle contraction as follows:

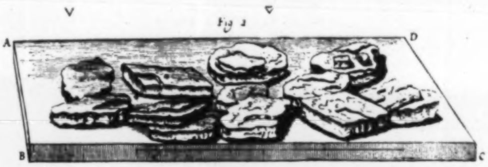
> A chain of small Bladders fastened together so as by blowing into one Pipe, the whole might be successively fill'd, and by that means contracted, supposing the Fibres of the Muscles which seem'd like a Necklace of Pearls in the Microscope, might be fill'd with a very agill Matter, which he thought most likely to be Air, which being included in so thin Skins, was easily wrought upon by Heat, Cold or the acting Properties of the Liquors that pass between them, and so performs the lengthening and contracting of the Muscles.

Hooke made certain interesting observations on urinary sediments, which he described thus:

> A tartareous substance, generated out of a Saline and a terrestrial substance crystalliz'd together, in the form of Tartar, sometimes sticking to the sides of the Urinal, but for the most part sinking to the bottom, and there lying in the form of coarse common Sand; these, through the Microscope, appear to be a company of small bodies, partly transparent, and partly opacous, some White, some Yellow, some Red, others more brown and duskie colours. The Figure of them is for the most part flat, in the manner of Slats, or such like plated Stones, that is, each of them seem to be made up of several other thinner Plates.

An excellent drawing of these crystals is reproduced with the description, which taken with their solubility in oil of vitriol and spirit of urine without ebullition proves them to have been uric acid crystals. By these solvents Hooke noted that the crystals were made "very white, not vitiating, but rather rectifying their Figure, and thereby make them afford a very pretty object for the Microscope." The goal of the ancient lithotomists and modern urologists is suggested by the remark that "some menstruum [might be found to] dissolve [Stone] without hurting the Bladder." However Hooke left the solution of this problem to the "Physicians or Chymists."

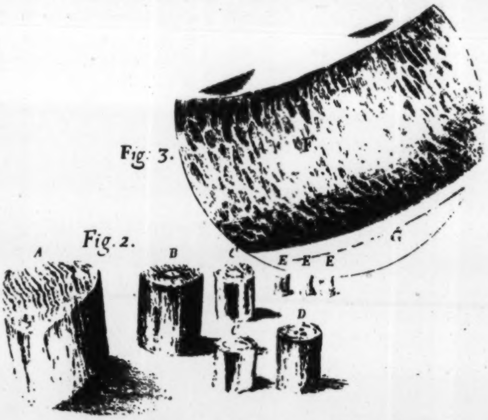
His further studies in microscopy included observations on the crystalline figures in frozen urine, which he resolved into a basic six-branched order. In an extensive comparative study of hair Hooke derived the existence of innumerable pores, in their apparently continuous surface, for the elimination of excrementitious matter. By what artifact this egregious error arose is not apparent, since no such pores appear in his excellent drawings. It is, however, interesting that a popular misconception of a central canal in the shaft of the hair for the secretion of sebaceous material has survived generations of scientific disavowals. Robert Hooke was active in microscopic researches of a widely diversified order apart from those with a bearing on medicine. In the study of the minute cavities in cork (1665) he first applied the term cell in the biologic sense, referring to the tissue as composed of "little boxes or cells distinct from one another" and separated by solid walls.



DRAWING OF CRYSTALS FROM THE URINE (FROM HOOKE).

The microscope devised and used by Robert Hooke was a model of mechanical completeness and ingenuity. To this apparatus the field lens of Monconys was adapted by Hooke with no thought of avoiding spherical aberration but simply to enlarge the field. The cup-like ocular had obvious advantages. The handsomely embellished barrel was mounted on a stand, admitting of movement in all planes; even crude fine adjustment was attainable by turning the barrel. The oil lamp constituted an uncertain source of illumination and was attached to a second standard. The light from this source passed through a cobbler-ball and then was focussed by means of a plano-convex lens on the object. Adjustment of each of the elements in the lighting system was possible in practically all planes.

In common with all philosophers of his time Hooke delved into the origin and meaning of life. He reasoned:

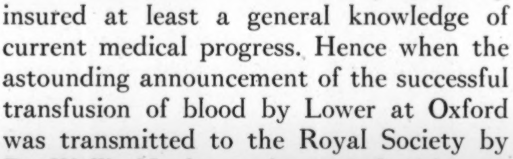


MICROSCOPIC APPEARANCE OF HAIR (FROM HOOKE).

> There is but a small difference between Earth and strong Concretions, between such Concretions and Salt, between the crystallizing and shooting of Salt, and the Vegetation of Mould, and less between the Vegetation of Mould and Mushrooms, and but a very little between the Vegetation of Mushrooms and Moss, and as little between Moss and Grass, and between Grass and the most bulky Vegetable and no great matter between the Vegetation of Plants and Zoophyts, and there is no great difference between Maritime Zoophyts and Oysters, Blubbers and the like; between those and Periwinkles, and other kinds of Shell-fish, between Shell-fish and crustaceous Creatures, between those and Fishes, between Fishes and amphibious Creatures, such as Morses and Sea-Calves, and the like, between those and Aerial Animals, etc.

Here the fantasy ends.

Robert Hooke was acquainted with the works of Pecquet, Bartholinus, Billius, Harvey, Ent, Willis and Glisson. His intimate connection with the Royal Society insured at least a general knowledge of current medical progress. Hence when the astounding announcement of the successful transfusion of blood by Lower at Oxford was transmitted to the Royal Society by Dr. Wallis, Hooke was instructed on August 22, 1666, to make preparations for the repetition of these experiments. The great London Fire, which spared Gresham College, deferred this demonstration, but on November 14, 1666, a transfusion was successfully performed by Mr. King and Mr. Cox to the complete satisfaction of the Fellows. Two days later Samuel Pepys reported: "This noon met Mr. Hooke, who tells me the dog which was filled with another dog's blood at the College the other day is very well, and like to be so ever, and doubts not its being found of great use to men, and so Dr. Whistler, who dined with us at the tavern."



The Microscope of Robert Hooke (From Hooke).

To the study of the senses Hooke gave especial attention. Pointing out their imperfection in man, he stated that in the lower animals:

> They seem to have been made purposely for the peculiar Use of each several species: The Sight for discovering Conveniences and Inconveniences at a great Distance as well as near at hand: The Ear, for receiving Warning or Information from Sound, where the Eye could not assist: The Nose, for distinguishing by the Effluvia of Bodies, of wholsome or unwholsome Nourishment: The Taste for the same purpose, by the Dissolution of them in the Mouth, and for the determining of the Quantity requisite to be taken at a time: The Feeling, for the Sensation of External Textures or Motions. But yet the greater Perfection of Ratiocination in Man may make them capable of other kind of Information.

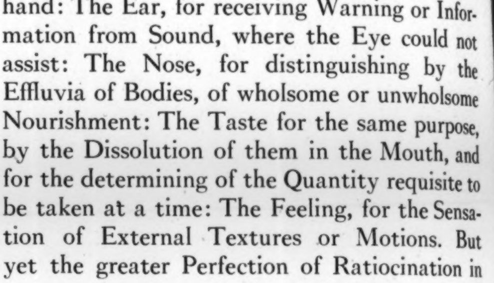


Diagram of the Eye; Drawing of Artificial Eye (From Hooke).

From this viewpoint a separate consideration of the several senses was undertaken. His knowledge of the anatomy of the eye was complete and his description of its several components adequate. In the physiology of vision Hooke followed Descartes. He was familiar with Mariotte's observations on the functions of the chorioid and the retina, but opposed the latter in holding the retina to be the receptive layer for visual impressions. The limitation of visual perception to objects subtending an angle of more than a minute was recognized, but the aid of the lenses in reducing this deficiency was expounded. To him vision was the greatest of the senses, the eye constituting in effect a microcosm. "For the Fabrick of the Eye, it is in it self so truly admirable, that there is nothing in the whole Creation better deserves our Contemplation, and wherein the Wisdom and Design of the Great Creator more sensibly appears." Hooke constructed a crude artificial eye for the study of optics, in which field his knowledge of physics, mathematics, anatomy and physiology peculiarly prepared him for accurate observations. As an outcome of these studies the use of the convex lens was suggested for the myopic (*Myopibus Juvamen*). Hooke believed the individual using the lens would naturally readjust himself to the inversion of the object or added that the object itself might be inverted to afford an upright image.

Hooke made an exhaustive study of sound and acoustics. His contemporaries were inclined to ridicule his nicely drawn deductions. Pepys, for instance, thought his discourse on musical notes was an excellent presentation but that his pretension "to tell how many strokes a fly makes with her wings a little too much refined." Hooke was thoroughly grounded in the physics of sound, nevertheless. For the improvement of hearing he devised two Otocousticons which he demonstrated to the Royal Society. In this direction these experiments on telephony are most interesting:

> 'Tis not impossible to hear a whisper a furlongs distance, it having been already done; and perhaps the nature of the thing would not make it more impossible, though that furlong should be ten times multiply'd . . . It has not been yet thoroughly examin'd, how far Otocousticons may be improv'd, nor what other ways there may be of quickening our hearing, or conveying sound through other bodies then the Air: for that is not the only medium, I can assure the Reader, that I have, by the help of a distended wire, propagated the sound to a very considerable distance in an instant, or with as seemingly quick a motion as that of light, at least, incomparably swifter then that, which at the same time was propagated through the Air; and this not only in a straight line, or direct, but in one bended in many angles.

To the student of medical history Robert Hooke's relation to the development of mediate auscultation must prove interesting. One hundred and fifty years before the epochal discovery of the stethoscope by Laënnec, Hooke in the following words anticipated its invention and use:

> There may also be a possibility of discovering the Internal Motions and Actions of Bodies by the sound they make, who knows but that as in a Watch we may hear the beating of the Balance, and the running of the Wheels, and the striking of the Hammers, and the grating of the Teeth, and multitude of other noises; who knows, I say, but that it may be possible to discover the Motions of the Internal Parts of Bodies, whether Animal, Vegetable, or Mineral, by the sound they make, that one may discover the Works perform'd in the several Offices and Shops of a Man's Body, and thereby discover what Instrument or Engine is out of order, what Works are going on at several times, and lie still at others, and the like; that in Plants and Vegetables one might discover by the noise the Pumps for raising the Juices, the Valves for stopping it, and the rushing of it out of one Passage into another, and the like. I could proceed further, but methinks I can hardly forbear to blush, when I consider how the most part of men will look upon this: But yet again, I have this Incouragement, not to think all those things utterly impossible, though never so much derided by the Generality of Men, and never so seemingly mad, foolish, and phantastick, that as the thinking them impossible cannot much improve my Knowledge, so the believing them possible perhaps may be an occasion of taking notice of such things as another would pass by without regard as useless. And somewhat more of Incouragement I have also from Experience, that I have been able to hear very plainly the beating of a Man's Heart, and 'tis common to hear the motion of Wind to and fro in the Guts, and other small Vessels, the stopping of the Lungs is easily discovered by the Wheezing, the Stopping of the Head, by humming and whistling Noises, the slipping to and fro of the Joynts in many cases, by crackling, and the like. As to the working or motion of parts one amongst another, methinks I could receive

> Incouragement from hearing the hissing noise made by a Corrosive Menstruum in its operation, the noise of the Fire in dissolving, of Water in boiling, of the parts of a Bell after that its motion is grown quite invisible as to the eye; for to me these Motions and the other seem only to differ secundum magis et minus, and so to their becoming sensible, they require that their motion be increased, or that the Organ be made more nice and powerful to sensate and distinguish them (to try the contrivance about an artificial tympanum) many cases there may be Helps found, some of which I may, as opportunity is offered, make Trial of, which, if successful and useful, I shall not conceal.

From this passage in his "Posthumous Works," there can be little doubt of Hooke's actual, though desultory, use of the stethoscope. As in so many other instances he had simply time to blaze the trail and frequently his contribution was too evanescent to make itself felt in the light of true scientific advance. In this case his concluding sentence seals his doom for any claim of priority.

Hooke's appreciation of the physiology of the senses of smell and taste is best testified by the following quotation:

> The Smell being caused by a subtil and curious Exhalation from the odoriferous Body imbibed by the Air, the Olfactory Nerves are prepared with an aerial Body fit to dissolve or imbibe that Substance in the same manner as the Air does from the odoriferous Body; which aerial Body, by means of the Olfactory Nerve, having an immediate Intercourse and Passage to the Brain, does immediately convey it thither: And according to the nature of this aerial of spirituous Substance with which the Olfactory Nerve is furnished, so does it dissolve or imbibe this or that Exhalation out of the Air. Whence I conceive that it is of distinct Natures in every Species of Animals, and thence that every one of them have distinct Sensations of the same Effluvia, and that which is congruous and agreeing to one is of a contrary nature to another, and thence what is grateful to one, is odious to another. And again, what is sensible to one sort of Creature, who has an aerial Substance fitted to dissolve and imbibe such or such a Stream, is wholly insensible to another that wants that aerial Substance, and is furnisht with one of a differing Nature. Which I conceive to be the reason, why Dogs and other Creatures have so strong a Faculty of smelling the Scent of Animals, or the Flesh of them, which are hardly discoverable to a Man. On the other side, in probability Man is sensible to many things, as the smell of Flowers, Herbs and Fruits, which possibly a Dog does very little if at all Scent.
>
> The like may be said of the Taste, which I conceive lies only in the Nature of the watery Liquor conveyed by the Nerves of Taste to the Tongue, according to the Nature of which for dissolving this or that Substance of the Bodies touching it, is the Impression of Taste conveyed by the Brain. And so we may see a clear Reason why one Taste may be tasted by one, which is not by another, and why one Taste is pleasant to one Creature which is not so to another, and how a Body becomes gustable or tasteless, and how that which is tasteless in it self may be made tastable, and why that which is tastable may be made tasteless.

Hooke devoted considerable time and thought to the study of memory, which he likened to a warming stone where impressions are absorbed and held. "Memory [is] as much an Organ as the Eye, Ear or Nose and [has] its Situation somewhere near the Place where the Nerves from the other Senses concur and meet." The amnesia attendant upon sickness, injury or alcoholic debauch constituted in his opinion evidence for a separate organ of memory. The complex subject of the soul was likewise a field for philosophical rumination on his part.

The nature of combustion was a pregnant subject among philosophers of that period. In a study, "Of Charcoal, or burnt Vegetables," which appeared in "Micrographia" (1665), Hooke first propounded the thesis "that the Air in which we live, move and breath, and which encompasses very many, and cherishes most bodies it encompasses, that this Air is the menstruum, or universal dissolvent of all Sulphureous bodies." He further pointed out the generation of heat from this dissolution, called fire. Significantly Hooke then noted that:

> The dissolution of sulphureous bodies is made by a substance inherent, and mixt with the Air, that is like, if not the very same, with that which is fixt in Salt-peter, which by multitudes of Experiments that may be made with Salt-peter, will, I think, most evidently be demonstrated. . . .
>
> It is observable, that as in other solutions, if a copious and quick supply of fresh menstruum, though but weak, be poured on, or applied to the dissoluble body it quickly consumes it: So this menstruum of the Air, if by Bellows, or any other such contrivance, it be copiously apply'd to the shining Body, is found to dissolve it as soon, and as violently as the more strong menstruum of melted Nitre.

Proceeding logically in his deductions, Hooke concluded:

> It seems reasonable to think that there is no such thing as an Element of Fire that should attract or draw up the flame, or towards which the flame should endeavor to ascend out of a desire or appetite of uniting with that as its Homogeneal primitive or generating Element; but that that shining transient body which we call Flame, is nothing else but a mixture of Air, and volatil sulphureous parts of dissoluble or combustible bodies, which are acting upon each other whils't they ascend, that is, flame seems to be a mixture of Air, and the combustible volatil parts of any body, which parts the encompassing Air does dissolve or work upon, which action, as it does intend the heat of the aerial parts of the dissolvent, so does it thereby further rarifie those parts that are acting, or that are very near them, whereby they growing much lighter than the heavie parts of that Menstruum that are more remote, are thereby protruded and upward.

This revolutionary conception of combustion was advanced by Hooke over a decade before the very similar theory of the nitro-aerial spirit was expounded by Mayow. The latter although unquestionably cognizant of Hooke's teaching, gave him no credit in the advancement of the theory. Hooke's explanation of combustion was largely theoretical, although his background of common observation was sound.

The experimental method was not entirely wanting in his proof, as witness:

> Without Air no such dissolution of Sulphureous Bodies will follow tho' the heat apply'd be never so great, which was try'd particularly by a Charcoal enclosed in an Iron Case with a Screw-stopper, which tho' violently heated yet the Cole was not burnt nor wasted when taken out. . . . Candle will presently go out if inclos'd in a Vessel, whereby the fresh Air is excluded: The like it will presently do, if it be included in a larger Vessel, and the Air drawn out. Coles likewise will do the same, if included in a close Vessel, nay though by a pair of Bellows included in the Box with them they be all the time blown upon by them, as I have several times shewn before very many illustrious Spectators.

Hooke recognized the dependence of light upon combustion and demonstrated that the use of bellows induced blazing by furnishing added fresh air rather than by the simple mechanism of removing ashes, as had been maintained. Interesting in this relation is his experiment of supplying "satiated" air in place of fresh air through the bellows with the apparent result of extinguishing the fire. A return of fresh air relighted the "seemingly extinct and black Coles."

The natural outgrowth of this train of thought was its application to respiration in animal life. Hooke clearly pictured this analogy:

> Somewhat like this is observable in the Life of Animals, who live no longer than they have a constant supply of fresh Air to breath, and, as it were, blow the Fire of Life; for so soon as that supply is wanting, the Fire goes out, and the Animal dies, and all the other vital functions cease; as anyone may presently see, if he puts a small Animal as a Bird, or the like, into a small Glass and covers it close; for in a short time the Air becomes satiated, and is no longer fit for respiration; but though the Animal breath it as before, and Pant and move his Lungs as before; yet if the Air be not fresh, the Fire of Life will extinguish. Some Learned Philosophers and Physicians have been of the Opinion, that the use of breathing was for nothing else, but that by the Motion of the Lungs the Blood might be kept circulating which past through them, or that the Steams of the Blood might be carried

> off, which it could not do when it was full of Steams; but by many Trials I have proved that neither of those are at all the Cause of the Death of the Creature, but only the want of fresh Air For whether the Lungs move or not move, if fresh Air be supplied the Animal lives, if it be wanting, it dies. Again, If the Air be full of Steams or not full of Steams, it is all one, the Animal lives if it be fresh, but if it be not, it dies; nor does the heat or Cold of it do anything.

Hooke's grasp of the subject of oxidation and respiration is especially noteworthy since he worked before the days of Black, Priestley and Lavoisier. Hooke devised the following ingenious experiment to prove that the respiratory movements of the lungs were unnecessary to life (1667):

> I did heretofore give this Illustraous Society an account of an Experiment I formerly tryed of keeping a Dog alive after his Thorax was all display'd by the cutting away of the Ribs and Diaphragme; and after the Pericardium of the Heart also was taken off. But divers persons seeming to doubt of the certainty of the Experiment (by reason that some Tryals of this matter, made by some other hands, failed of success) I caus'd at the last Meeting the same Experiment to be shewn in the presence of this Noble Company, and that with the same success, as it had been made by me at first; the Dog being kept alive by the Reciprocal blowing up of his Lungs with Bellows, and then suffered to subside, for the space of an hour or more, after his Thorax had been so display'd, and his Aspera arteria cut off just below the Epigllotis, and bound on upon the nose of the Bellows.
>
> And because some Eminent Physicians had affirm'd, that the Motion of the Lungs was necessary to Life upon the account of promoting the Circulation of the Blood, and that it was conceiv'd, the Animal would immediately be suffocated as soon as the Lungs should cease to be moved, I did (the better to fortifie my own Hypothesis of this matter, and to be the better able to Judge of several others) make the following additional Experiment; viz.
>
> The Dog having been kept alive, (as I have now mentioned) for above an hour, in which time the Tryal hath often been repeated, in suffering the dog to fall into Convulsive motions by ceasing to blow the Bellows, and permitting the Lungs to subside and lye still, and of suddenly reviving him again by renewing the blast, and consequently the motion of the Lungs: This I say, having been done, and the Judicious Spectators fully satisfied of the reality of the former Experiment; I caused another pair of Bellows to be immediately joyn'd to the first, by a contrivance, I had prepar'd, and pricking all the outer coat of the Lungs with the slender point of a very sharp penknife, this second pair of Bellows was mov'd very quick, whereby the first pair was always kept full and always blowing into the Lungs; by which means the Lungs also were always kept very full, and without any motion, there being a continual blast of Air forc'd into the Lungs by the first pair of Bellows, supplying it as fast as it could find its way quite through the Coat of the Lungs, by the small holes pricked in it, as was said before. This being continued for a pretty while, the dog, as I expected, lay still, as before, his eyes being all the time very quick, and his Heart beating very regularly: But, upon ceasing this blast and suffering the Lungs to fall and lye still, the Dog would immediately fall into Dying convulsive fits; but be as soon reviv'd again by the renewing the fulness of his Lungs with the constant blast of fresh Air.
>
> Towards the latter end of this Experiment a piece of the Lungs was cut quite off; where twas observable, that the Blood did freely circulate, and pass through the Lungs, not only when the Lungs were kept thus constantly extended, but also when they were suffered to subside and ly still. Which seem to be Arguments, that as the bare Motion of the Lungs without fresh Air contributes nothing to the life of the Animal, he being found to survive as well when they were not mov'd, as when they were; so it was not the subsiding or movelesness of the Lungs that was the immediate cause of Death, or the stopping the Circulation of the Blood through the Lungs, but the want of a sufficient supply of fresh Air.
>
> I shall shortly further try, whether the suffering the Blood to circulate through a vessel, so as it may be openly exposed to the Fresh Air, will not suffice for the life of an Animal; and make some other Experiments, which, I hope, will throughly discover the Genuine use of Respiration; and afterwards consider of what benefit this may be to Mankind.

This carefully planned experiment establishes the fundamental quality of Hooke's observations and places him among the first of the experimental physiologists. In the study of oxidation and respiration he was a pioneer greatly in advance of his time.

Animal heat was the subject of much conjecture at that time. The prevalent theory advanced the interaction of body juices one on another as the cause for heat production. Hooke believed its origin to be in the uniting of the "Volatile Salt of the Air" with the blood in lungs leading to a type of corrosion. In support of this contention he pointed out the fact that "only those Animals that breath much are very hot, all other kinds of them are even cold to a Man's touch, as Fishes, Snakes, Frogs, Cameleons, etc." The excretory function of the lungs was appreciated, not only in relation to gases but also to other noxious substances.

Hooke's studies on respiration aroused his curiosity as to the efficacy of the common sponge in enabling divers to remain under water for a longer period than was possible without its aid (1665).

> That use which the Divers are said to make of it, seems, if true, very strange, but having made trial of it myself, by dipping a small piece of it in very good Sallet-oyl, and putting it in my mouth, and then keeping my mouth and nose under water, I could not find any such thing; for I was so soon out of breath, as if I had had no Sponge, nor could I fetch my breath without taking in water at my mouth.

Characteristically, he then suggested:

> Were there a contrivance whereby the expir'd air might be forc'd to pass through a wet or oyly sponge before it were again inspir'd, it might much cleanse, and strain away from the Air divers fuliginous and other noisome steams, and the dipping of it in certain liquors might, perhaps, so renew that property in the Air which it loses in the Lungs, by being breath'd, that one square foot of Air might last a man for respiration much longer, perhaps, then ten will now serve him of common Air.

Nor was this very plausible solution of the problem of respiration in a diving bell Hooke's only suggestion in this direction. As early as February, 1663, he had proposed a method of supplying fresh air to a diving bell by means of a chain of buckets.

As has been previously pointed out, the wider scientific contact and the productive period of Robert Hooke's life were intimately linked with the Royal Society, to which he came as curator in 1662. On his arrival he was unanimously invited to sit with the Fellows and thereafter took a most active part in their proceedings. To them he gave unsparingly of his time and energy. In view of his peculiar relationship as curator, Hooke was exempted from dues; and on January 11, 1665, the position was made perpetual with a yearly salary of thirty pounds. In addition he was given an apartment in Gresham College, Bishopsgate Street, which he occupied for the remainder of his life. March 20, 1665, he became professor of geometry at Gresham College, and for the years 1664–1665 gave the lectures in astronomy there for Dr. Pope. On the death of Henry Oldenburg in 1677, Hooke was made secretary of the Royal Society and held this position of honor for five years.

From a financial standpoint the early years of Hooke's stay in London were precarious. Recognizing the situation Sir John Cutler made the offer of a lectureship in mechanics to the Royal Society in 1664 upon which this body took the following action:

> Sir John Cutler having founded a Lecture, and settled an Annual Stipend upon Robert Hooke, M. A. of fifty Pounds during Life (entrusting the President, Council and Fellows of the said Society to direct and appoint the said Mr. Hooke as to the Subject and Number of his Lectures) the Society order'd several of their Members to wait upon Sir John Cutler, with their Thanks for his particular Favour to a worthy Member, and for that Respect and Confidence he hath thereby exprest towards their whole Body, etc.

Hooke was constrained to refer to his benefactor as "an eminent Ornament of this renowned City and one . . . not easie to be deceived." This state of mutual confidence did not survive. A suit in chancery evolved on Sir John Cutler's failure to fulfill his share of the contract. Finally with the support of the Royal Society, on July 18, 1696, his suit was won and Hooke wrote in his journal, "DOMSHLGISSA*—I was Born on this Day of July 1635, and God has given me a new Birth, may I never forget his Mercies to me; whilst he gives me Breath may I praise him."

The financial arrangement with the Royal Society was likewise the basis of considerable bickering. In 1679 the Fellows:

> Resolved, that in consideration of the propositions made by Mr. Hooke for a more sedulous prosecution of the experiments for the service of the Society, and the drawing up into treatises several excellent things which he had formerly promised the world; the Council, as an encouragement, according to the poor abilities of the Society, have agreed to adde forty pounds for this year, ending at Christmas, to Mr. Hooke's salary.

After another lapse of years in 1687, Robert Hooke proposed to deliver one discourse with one or two experiments before the Society weekly for a recompense of one hundred pounds a year. It was at this time that they compromised on a salary of fifty pounds a year from the Society with its active support in obtaining the Cutler grant of a similar amount, which had been withheld by the donor. To this arrangement apparently Hooke did not accede, since he continued to make scientific communications to the Society but gave no set experimental lectures. In 1688 the Society voted Hooke ten pounds a year for the use of his rooms in Gresham College. On one occasion he asked for six months' time in which to consider the Fellows' proposal that he accept books in substitution for a portion of his salary.

During Hooke's residence in London two of the most horrible calamities in the history of the English people visited that city. According to Defoe's fictitious saddler the first portentous comet appeared above the ill-fated city in 1665. The majority of the Fellows being men of means, they left the plague-stricken city early and on June 26, 1665, the weekly meetings were discontinued. Henry Oldenburg, the secretary, maintained his residence in Pall Mall and from here addressed his notes of scientific interest to his panic-stricken brethren in the country. The desolated town, now reeking with the stench of the dead, and striving blindly by impotent quarantine, watchmen, incantations and potions to throw off the spell of the mysterious visitation, offered little inducement for the continued stay of Hooke. As assistant to Dr. Wilkins and Sir William Petty, Hooke found congenial employment and security at Durdans, the country seat of the Earl of Berkeley near Epsom. Men, prominent in the world of medicine, as Sydenham, deserted their posts of duty, following their clientele to the country and on their safe return wrote profoundly of the horrors of the plague they had not the courage to face. Others, as Glisson and Paget, men of steel, faced the "pestilence that walketh in darkness" and earned the undying gratitude of their fellow-men by their devotion to the afflicted in the homes, whose doors bore the ominous red cross and the inscription, "Lord, have mercy upon us." By March 14, 1666, a quorum of Fellows was available and the Society resumed its meetings in Gresham College.

The second ominous star appeared over London in 1666 and on Sunday, September 2, the Great Fire broke out in the city. While Gresham College was spared, as has been previously stated, it was turned over to the civic authorities for their use in the emergency. The Society met at Arundel House in the Strand for a time. On September 16, 1666, Robert Hooke presented before the Society a model for the rebuilding of the city, which placed the streets at right angles and developed a comprehensive arrangement of public buildings, churches and markets. The Lord Mayor and the aldermen approved his plan above that submitted by the city surveyor, and presented it to the King. The plan of Sir Christopher Wren was finally adopted. In recognition of his efforts Hooke was made surveyor, a most remunerative position in such times. He planned several public buildings at this period.

---

* (Translation) Deo Opt. Max Summus Hono Laus Gloria in secula secularum, Amen.

Of Hooke's works, "Micrographia" is the best known and most remarkable. Published by order of the Council of the Royal Society in 1665, this large volume represents in effect his original scientific observations of three years' time, albeit interspersed with much philosophizing. Its materials were presented in the main before the Society, and Sir Christopher Wren assisted Hooke in its compilation. The volume was dedicated to Charles II, whom it flattered as the patron of philosophy and experimental learning. In the Preface are found several interesting notes:

> Hence we often take the shadow of things for the substance, small appearances for good similitudes, similitudes for definitions; and even many of those, which we think to be the most solid definitions, are rather expressions of our own misguided apprehensions then of the true nature of the things themselves . . .
>
> We are not only to contend with the obscurity and difficulty of things whereon we work and think but even the forces of our own minds conspire to betray us.

The *Transactions of the Royal Society* were discontinued in 1678. In the succeeding year Hooke started the publication of Philosophical Collections, which went to seven numbers under his editorship and incorporated his own discourses before the Society. In 1705 Richard Waller published the "Posthumous Works of Robert Hooke," which include many of the latter's unpublished contributions. The field of these communications ranged through a wide gamut of science and philosophy, dealing among other things with light, memory, gravity, earthquakes, astronomy and mechanical devices. It is beside the purpose of the present dissertation to enter upon the several subjects beyond those above cited with reference to their medical bearing.

Although not a physician by training, Hooke had served under a master in the person of Thomas Willis at Oxford. His scientific interest and researches had frequently led him into subjects related to medicine. Hence it was peculiarly fitting that in December, 1691, having received a warrant from Dr. Tillotson, Archbishop of Canterbury, for the degree of doctor of physic, Robert Hooke should take the oath before Sir Charles Hedges in the Doctors' Commons.

Waller has left to posterity the most vivid picture of Hooke. Of his characteristics, he noted:

> His Temper was Melancholy, Mistrustful and Jealous, which more increas'd upon him with his Years. He was in the beginning of his being made known to the Learned, very communicative of his Philosophical Discoveries and Inventions, till some Accidents made him to a Crime close and reserv'd. He laid the cause upon some Persons, challenging his Discoveries for their own, taking occasion from His Hints to perfect what he had not; which made him say he would suggest nothing till he had time to perfect it himself, which has been the Reason that many things are lost which he affirm'd he knew.

Hooke's controversy with Sir Isaac Newton in the matter of the latter's theory of the refrangibility of light was of this origin. Hooke maintained that the substance of Sir Isaac's contribution had appeared in "Micrographia," Sir Isaac stoutly insisted on his priority, but a conciliatory note from Hooke elicited a statement of obligation to his work from Newton. However, Newton's work on optics was suppressed until after Hooke's death to avoid contention. He referred to Hooke as the "irritable philosopher." Because of the jealousy of Hooke toward Sir Isaac Newton the latter was not elected to the council of the Royal Society until the former's death and singularly was made president of the Society on the same day.

Robert Hooke was a disputatious soul. The Royal Society on one occasion forced him to withdraw a statement that Oldenburg was a "trafficker in intelligence." The erection of a turret over his Gresham College quarters for astronomical purposes together with a correspondence with Edmund Halley, stimulated Hooke's interest in the heavenly bodies. The recall of the loaned instrument from Greenwich Observatory by the Council of the Society incited the wrath of Flamsteed, who remarked that Hooke had wrested the quadrant from him. Not satisfied with petty quarrels with his associates, Hooke went far afield to squabble with Huygens over the mechanism of the watch and with Hevelius in the matter of the relative merits of the plain and the telescopic sights for astronomical observations. Hooke was so patently correct in his position supporting the use of the telescopic sights that only his acrimonious habit turned popular judgment against him. Robert Boyle alone seems to have maintained his confidence and friendship. Always a recluse, his later years saw his morbidly suspicious attitude develop into a frankly psychopathic state.

Waller's portrayal of the physical Robert Hooke cannot be improved upon:

> As to his Person he was but despicable, being very crooked, tho' I have heard from himself, and others, that he was strait till about 16 years of Age when he first grew awry, by frequent practicing with a Turn-Lath, and the like incurvating Exercises, being but of a thin weak habit of Body, which increas'd as he grew older, so as to be very remarkable at last: This made him but low of Stature, tho' by his Limbs he shou'd have been moderately tall. He was always very pale and lean, and latterly nothing but Skin and Bone, with a meagre Aspect, his Eyes grey and full, with a sharp ingenious Look whilst younger; his Nose but thin, of a moderate height and length; his Mouth meanly wide, and upper Lip thin; his Chin sharp, and Forehead large; his Head of a middle size. He wore his own Hair of a dark Brown colour, very long and hanging neglected over his Face uncut and lank, which was about three Years before his Death he cut off, and wore a Periwig. He went stooping and very fast (till his weakness a few Years before his Death hindred) having but a light Body to carry and a great deal of Spirits and Activity, especially in his Youth.

In 1687 his niece, Mrs. Grace Hooke, who had been his companion and housekeeper, died. A period of marked mental depression succeeded. His habitual headaches became more frequent and severe. Vertigo and syncopal attacks supervened. In one of these he fell down a flight of stairs (July, 1697) and never completely recovered from the shock of the injury. He was said to have suffered from scurvy. For more than a year Hooke was bedridden by reason of extreme edema of the legs, which eventually broke down. His vision failed until he became totally blind. At the end he was greatly emaciated. He died March 3, 1702, at the age of sixty-seven years and was buried in the Church of St. Helen, Bishopsgate Street, attended by the Fellows of the Royal Society as befitted "his extraordinary Merit."

Robert Hooke's interest in the Royal Society outlasted his physical capacity to participate in its proceedings. His friend, Edmund Halley, read a paper on the marine barometer devised by Hooke before the Society at the latter's request, while he was bedridden. Eight days before his death he applied to the Society for Cheyney's "Fluxionum Methodus Inversa." Prior to his death Hooke had frequently voiced his intention of leaving the bulk of his estate to the Royal Society and his friends urged that he make certain of such provisions in his will. At his death an iron chest containing several thousand pounds in silver and gold, presumably earned as surveyor in the reconstruction period after the Great Fire and untouched in the intervening thirty years, was discovered. The failure to locate a will lost this handsome legacy to natural science.

To the brilliant yet inconclusive career of Robert Hooke no more fitting characterization can be found than his own words:

> If I have contributed the meanest foundations whereon others may raise nobler Super-structures, I am abundantly satisfied; and all my ambition is that I may serve to the great Philosophers of this Age, as the makers and the grinders of my Glasses did to me; that I may prepare and furnish them with some Materials, which they may afterwards order and manage with better skill, and to far greater advantage.

Coat of Arms of the Royal Society.

# THE INFLUENCE OF THE THREE MONROS ON THE PRACTICE OF MEDICINE AND SURGERY

*By* S. WILLIAM SIMON, S.M.

CHICAGO

To consider the Monros rightly, it is necessary to review the contributions of the outstanding characters who lived during the eighteenth century, which marks the period held in common by these three. An important figure to be observed in the array of scientific stars is Linnaeus (1707–1778) who gave us the most concise descriptions of plants and animals, giving each a definite name, and placing each in a specific class. This tended to have an effect on medical men in classifying disease. Boerhaave (1668–1738), founder of the Eclectic School, stands out as one of the greatest clinicians of all time, and was one of the first to use the Fahrenheit thermometer in diagnosis. Albinus (1697–1770) marks the apex of anatomical illustration and his atlases remain yet unsurpassed. Spallanzani (1712–1799) contributed much to digestive and nervous physiology. Cullen (1712–1790) was instrumental in founding the medical school at Glasgow and was one of the first to give clinical or infirmary lectures in Great Britain, and his lectures were the first ever given in the vernacular instead of Latin (1757). Camper (1722–1789) gave to the world anatomical illustrations rivalled only by those of Albinus. Meckel, the elder (1724–1774), after whom the ganglion of the fifth nerve is named, described the submaxillary ganglion and made important investigations of the nerve supply of the face. Electrophysiology had its origin in the epoch-making experiments of Galvani (1737–1798) and Volta (1745–1827). Priestley (1733–1804) isolated oxygen in 1772. Lavoisier (1743–1794) advanced the theory of the exchange of gases in respiration. Wolff (1733–1794) marks the starting point of modern embryology, by his "Theoria Generationis" in 1759. Hewson (1739–1774) commands interest because of his controversies with Monro II. He was the partner of William Hunter and seemed to share his enmity for the Monros. Hewson's only real discovery was that fibrinogen was responsible for the clotting of blood. Comparative anatomy had as its sponsor Vicq d'Azyr (1748–1794); Scarpa (1747–1832) and Morgagni (1682–1771) brought anatomy and surgery to a point hitherto unreached.

The lucidae in this constellation, however, are William (1718–1783) and John Hunter (1728–1793) who are among the greatest physicians who ever lived, regardless of the strife between them and the Monros. William, with his culture, breeding and refinement, was an ideal teacher of anatomy. Of him Stephen Paget said: "He never married; he had no country house; he looked the part of a fastidious fine gentleman; but he worked till he dropped, and he lectured while he was dying." John, though as rough and unrefined in the matter of convention as his brother was cultured, still excels the latter in anatomical attainments. He is also noted for the accumulation of 13,000 specimens in his anatomical museum. By inoculating himself he endeavored to show the inseparability of venereal diseases. This has been called the bravest experiment ever performed. His lack of education probably hindered him from doing all of which he was capable. Cheselden (1688–1752) was one of the greatest surgeons of all time and he and Monro I often worked together. Jenner (1749–1823) gave to the world inoculative prevention of smallpox, probably saving more lives than any other one man. Benjamin Rush (1745–1813) was the greatest American physician of the century and he is said to have added much to the medicine of his time. Sir Charles

Bell (1774–1842) made himself known as an anatomist although his physiological and neurological studies, particularly on the spinal cord, are now adding much to his fame. In 1800, Sir Humphry Davy (1778–1829) experimented upon himself with nitrous oxide, and stated that "it may probably be used with advantage in surgical operations in which no great effusion of blood takes place." The use of anesthesia to any extent, however, was not begun until near the end of the life of Monro III and he leaves no writings on it.*

It is important to consider the conditions of disease at the beginning of the eighteenth century. Leprosy at that time was almost extinct. Syphilis was no longer epidemic and was treated by mercurial fumigation and inunctions at the hands of barber surgeons. Bubonic plague had broken out in certain large cities and because of the ignorance of medical men regarding it, there was high mortality. For typhus and typhoid, no real treatments were known. Periodically epidemic dysentery broke out, and it, too, claimed many victims. At this time, malarial fever had become pandemic. Diphtheria was epidemic almost constantly. Ergotism was prevalent in France, Switzerland and Germany at various times. Scurvy was the curse of armies and the cause of many defeats. Influenza, though little understood, was common in both the new and old worlds. Africa contributed a new problem, yellow fever. Smallpox which had been pandemic in the early seventeenth century, had become epidemic. It was thought necessary that every one have smallpox before he died. Scarlatina appeared about 1625 and spread from then on. The infantile mortality rate was exceedingly high; in England, at times, half of the births were wiped out by disease.*

Alexander Monro was descended by his father from the family of Monro of Milton and by his mother from that of Forbes. His grandfather, Sir Alexander Monro of Bearcrofts, and grand-uncle David, were both colonels in the army of King Charles at the battle of Worcester, where David was killed. Sir Alexander later gave up the army and became a lawyer. He had two sons. George, the eldest, also entered the army, and John studied medicine and surgery. After having finished his studies, he served for some years as a surgeon in the army under King William in Flanders. Before his appointment in the army, he had married his cousin, Miss Forbes, and for some years successively obtained leave of absence from the army in the winter, and resided with his wife in London, where his son Alexander was born September 8, 1697. About three years thereafter he quitted the army and settled in Edinburgh where he established quite an extensive practice. Perceiving early marks of superior talents in his son, an only child, he paid the greatest attention to his education. The son showed an early inclination for medicine, and the father, after giving him the best education that Edinburgh then afforded, sent him successively to London, Paris and Leyden. He studied under Cheselden in London and at the same time employed himself much in dissection, and being admitted a member of a society of young physicians and surgeons, he read to them the first sketch of his general account of the bones. From the bodies he dissected he made a great many anatomical preparations, which he sent home to his father; who, after showing them to the College of Physicians, gave them to be deposited in the cabinet of universities which was kept in the surgeon's hall; and Mr. Adam Drummond, who was professor and demonstrator of anatomy to the surgeons, was so well pleased with them that he declared if the young student continued to improve himself in the study of anatomy, as he had begun, he would resign in his favor when he returned to Edinburgh.

From London he went to Paris where he attended many hospitals and clinics.

---

* Extracted from Garrison, F. H. History of Medicine. Ed. 3, Phila., 1921.

Towards the end of the autumn, 1718, he went to Leyden and studied under the great Boerhaave, to whom he became particularly known, by having a great number of cases sent to him from Scotland. Boerhaave soon had a high opinion of Monro as a young practitioner and wrote a very favorable opinion of him to his friends. Monro, it seems, was very assiduous and gave great application to his studies wherever he went.

On returning to Edinburgh in the autumn of 1719, he received the appointment of demonstrator and professor of anatomy to the surgeons' company. Soon after his father prevailed upon him to read some public lectures on anatomy and to illustrate them by showing the anatomical preparations which he had made and sent home when abroad; and, without his knowledge, invited the president and fellows of the College of Physicians, and the whole company of surgeons to honor the first day's lecture with their presence. This unexpected company threw him into such confusion that he entirely forgot the words of the discourse he had written and memorized. Having left his papers at home, he was at a loss what to do; but having great presence of mind, he immediately began to show some of the anatomical preparations in order to gain a little time for recollection. Soon, however, he resolved not to attempt the discourse he had written but to talk from the subject which he was confident he understood. He delivered himself well and gained great applause as a good and ready speaker. After this, he never during his whole lifetime attempted, in teaching, to repeat the words of any written discourse but expressed himself in such words as came to him on the subject.

In the winter of 1720 he, with another professor, started the first regular courses of lectures on medicine that had ever been read at Edinburgh. His lectures were on anatomy and surgery. This event may be looked on as the opening of the Medical School at Edinburgh. About this time the physicians and surgeons of this city, largely due to the leadership of Dr. John Monro, established in the university regular professorships of anatomy and medicine. Dr. Monro became thus university professor of anatomy.

The students were much hindered due to the lack of demonstrations which were impossible without a hospital. Dr. Monro published a pamphlet setting forth the advantages of such an institution and after money enough had been subscribed, the hospital was built. Later, the needs became such that a larger hospital was erected with the help of every citizen in Edinburgh. In this hospital complete records of all cases were kept.

Dr. Monro, although professor of anatomy, was not inducted into the University until 1725. From then until his resignation in favor of his son, he regularly every winter gave a course of lectures on anatomy. In this course he began with a detailed history of anatomy, which he followed with osteology. In the latter, both the normal function and pathology of bones were considered. Next, he demonstrated, on adult subjects, the muscles, the abdominal and thoracic viscera, and brain, and showed the nerves and blood vessels in the dead bodies of children. Here, too, he elaborated on pathology. He also used the bodies of quadrupeds, fowls and fishes in his demonstrations. Later, the diseases treated by surgery were considered and the different bandages and machines used were shown. He concluded with some general lectures on the physiology of the human body.

He continued in this office nearly forty years and every year his classes grew. After he resigned he still read clinical lectures for students at the hospital. It is said that he personally attended the opening of every body.

Soon after the establishment of the hospital, there was organized a society for collecting and publishing such medical observations and essays as were presented by the physicians and surgeons of Edinburgh. Dr. Monro became the secretary and from 1732 on, the work of publishing the papers presented fell on him. Six volumes were published. These went through many editions and were translated into many languages. Many of the articles were contributed by Dr. Monro. The society was later enlarged to admit literary and philosophical scholars, at which time Dr. Monro became one of the vice-presidents.

He was a member of many societies for promoting medicine, literature, arts, sciences and manufacture. He managed many public charities. He was held in high estimation at home but he was equally esteemed and respected abroad, and was elected a member of the Royal Society at London and an honorary member of the Royal Academy of Surgery at Paris. He was a director of the Bank of Scotland, a Justice of the Peace and a Commissioner of High Roads.

As to his character, he is said to have been as amiable in private life as he was conspicuous in public. He furnished his father with every convenience that could be desired by a man in the decline of life. He was a great friend of civil liberty but in 1745 after the battle of Prestonpans he assisted the sick and wounded of the victors and the vanquished alike.

In 1725 Dr. Monro married Miss Isabella Macdonald, second daughter of Sir Donald Macdonald. He had eight children, four of whom died when young. Of the four remaining he had one daughter and three sons. Of the sons, Donald and Alexander II entered medicine, while John entered law.

Dr. Monro was a man of middle stature but possessed of great strength. He was subject to inflammatory fevers which he ascribed to the twice yearly bloodletting which he underwent in his youth. In 1762 he was attacked by influenza, probably intestinal, which caused the development of a fungous eroding ulcer of the rectum and bladder. He was in constant pain from May, 1766, until the day he died, July 10, 1767. He never complained of his state and viewed death without fear.*

The writings of Monro I have been collected in one volume by Monro II and since no dates have been given by him, none can be quoted as to the time of publishing of his works. The list of his works is given in the bibliography and the numbers following quotations refer to them.

The anatomical preparations of Monro I were great for three reasons. He was an able dissector, he knew how to prepare and preserve the parts of an animal and he improved much on the known art of injection. Bones, muscles and cartilage were first soaked in cold water and then dried in the sun intermittently. Dry preparations of the viscera were made with air or quicksilver while they were drying. After the parts were thoroughly dry a coat of varnish was applied. For moist fixing a rectified ardent spirit to which was added spirit of niter or vitriol was used.[2]

He injected minute blood vessels and membranous surfaces. Spiritous solutions were not used for this as he had observed that spirit of wine caused coagulation. A brass syringe was used. It was found best in fine injections to "first put in colored oil of turpentine in such quantity as might fill the very small vessels, and immediately after to push the common coarse injection into the larger ones." The oil penetrates into the smallest vessels and the colored matter is incorporated into it, thus making it impossible to discern that two injections have been made. His rules for injection were:

a. The younger the animal, the farther the injection will go.

b. The success of the operation will be greater, the more the creature's fluids have been dissolved and exhausted in life.

c. The less solid the part to be injected, the more vessels will be filled.

d. The more membranous and transparent parts show better on injection.[1]

Bones are represented in both their sound and diseased states in the works of Monro I.

---

* From the works of Alexander Monro, M.D., 1781.

His Osteology was intended for students who attended his lectures. To the descriptions of bones were added many practical observations and corollaries. This book went through eight editions during his life and was translated into many languages. He drops a hint to those who would write anatomy textbooks when he says: "Young anatomists' imagination cannot follow a long chain of descriptions, especially when they are not taught at the same time the uses which the described parts serve: their minds must have some relaxation by a mixture of reasoning."[3]

The marrow is thought to be the oily part of the blood, separated by small arteries and deposited in the cells of bones. It was supposed to soften and connect the fibers of bone. Although he did not understand how a fracture was repaired, he knew that the bone at that place was stronger afterward. It was known at this time where the synovial fluid originated but as to its fate: "After the liquor of the articulations becomes too thin and unserviceable by being constantly pounded and rubbed between the moving bones, it is reassumed into the mass of blood by the absorbent vessels."[3] One is kept interested in such a dry subject as osteology by his clever style and frequent surgical references. "One may know a Turk's skull," he says, "by its globular figure, a German's by its breadth and flatness of the occiput, Dutch and English by their oblong shapes." Resonance was a matter little understood as there was no adequate theory of sound but Monro held that "the sinuses and other cavities which open into the nose increase the sound of our voice, and render it more melodious by serving as so many vaults to resound the notes."[3]

Real intensive thinking after making observations was one of Monro's best traits. He noted that a man became smaller in stature as the evening approached and attributed this to the flattening of the vertebral articular cartilages while the body is in an upright position. Again, in regard to the ossa sesamoidea: "They seem to me nothing else than the ligaments of the articulations or the firm tendons of strong muscles, or both, become bony, by the compression they suffer." And still again, a female skeleton differs from the male due to the female having "a weak lax constitution, a sedentary inactive life, and a proper frame for being mothers."[3]

It is rather unnecessary to add that this volume considers all of the bones of the body, their relations, articulations, coverings, attachments, blood and nerve supply, and uses. Many of the names of the bones are much changed by the B.N.A. nomenclature, as the lacrimals, ossa unguis; the zygomatics, ossa malarum; the inferior nasal conchae, ossa spongiosa; the patella, rotula.

At this time, the digastric muscles were considered depressors of the lower jaw. In regard to this:

> In all portions of the hyoid bone in respect to the jaw, the obliquity of the muscles backward is great enough to oblige the condyles of the lower jaw, when advanced on the tubercles, to slide back into the cavities in the time of their action; by which luxations are prevented. Let anyone's head be pulled or pushed violently backward, his jaws are pressed strongly together, and his throat is tense with his larynx advanced, while he strains to resist the force applied: this the painters seem to have been abundantly more sensible to than anatomists.[5]

The question as to just what the chorda tympani is a branch of is discussed in connection with the lower jaw. The prevailing opinion was that it was a branch of the fifth cranial nerve. Monro I thinks it is rather the seventh cranial nerve. This dispute ended with the work of Monro II, who said it was a branch of both.[63]

Monro's work on luxation[5] brought forth much comment from outstanding anatomists of the day, as Winslow, Ferrein and Walther. A Monro has never been known to let criticism go unanswered and this is no exception to the rule. In his reply the sarcasm is scathing, the logic rare, and the humor great. Indeed, his opponents are truly answered. To Mr. Winslow he said in part:

> I should have thought myself very happy in being prevented from causing any original anatomical figures to be drawn, which I probably would have been, had Mr. Winslow given us the figures of all the parts of the body, as he intended; for, had the painters and engravers executed their parts with the same accuracy and candor, as he would have dissected and presented the originals to them, we should have had by far the most complete system of anatomy that ever yet has appeared, though as frailties must attend human nature, even a Winslow might have erred. Long may he live to do still more service to mankind; but I am afraid his great age will not bear the fatigue of such laborious work as these plates would require.[5]

It might be in place to add that at this time Winslow, a truly great authority on muscles, was about seventy years of age but he lived over twenty years after this.

As to the mode of action of the cartilages of the vertebral column, Monro says: "When we stand erect, each vertebra rests upon a fluid fulcrum or sort of pivot, the motion upon which to any side is easily and quickly performed."[6]

The diseases of the bones all seem to come under the common heading of "Caries." To set an example for scientific writers, Monro quotes Hippocrates, Celsus, Dioscorides, Galen, Paulus, the Arabians, Angelus Bolognius, Joannes de Vigo, Vesalius, Fallopius, Paré, Fabricius, Hildanus, Severinus, Tulpius, Wiseman and Petit and states: "People are too hasty in making conclusions, a single case or two has too often been the occasion of fixing a general rule for the cure of diseases."[7] Caries was always treated locally and it was never identified with other body pathology. Thus the treatment consisted of applying various medicaments to the part or by surgical removal thereof. The latter was probably the best but the death rate was very high (80 per cent) as due to the pain of the operation, the patient only consented as a last resort.

Monro wrote quite a bit on the lymphatics but understood little of them. It was for Monro II finally to put the lymphatics in their proper place. Monro dissected the lacteal sac and duct and noted its relations[7] but knew nothing of its function. On cases of lymphatics opened, his treatment was empirical.[8] As to the diseases of the lachrymal canals, he says: "Fistula lacrymalis is a common enough disease that has been often seen and treated by surgeons, yet in my opinion, is very little understood, and has very defective or faulty rules laid down for its cure."[29] In such diseases it is held better to keep the lacrymals open than to allow them to become closed.

A "Neurology" was added to the "Osteology" in its later editions. Here there are described concisely the larger branches of the particular nerves; the description of the very minute branches being avoided as apt to confound young students for whom he wrote. "It has been thought," says he, "that the nerves had their rise from the side of the encephalon which is opposite to their egress from the skull but this is not fully demonstrated because a decussation in some parts is not a proof that it obtains universally."[10] We must remember that at this time the microscope was in its infancy and so the statement that "the nerves are composed of a great many threads lying parallel to each other" is remarkable and doubly so if we consider the theories of nervous conduction which were in vogue, as we shall soon see. From what is called the examination of the "minimum visible, it is demonstrated that each fiber of the retina, or expanded optic nerve, cannot exceed the size of the 32,400th part of a hair."[10] The protective coats were thought to prevent the nerves from expanding too much. The ganglia were noted but no purpose ascribed to them. A nerve fiber had "no union, confusion or immediate communication from its origin to its termination."[10] He knew that "an injury done to any part of the spinal marrow, immediately affects all the parts whose nerves have their origin below this point."[10]

The theories of nervous conduction are a stumbling block. The vibratory theory is discarded as the only difference in conduction would be in the amount of vibration and this, it is said, would not give different sensations. Also our ideas would be confused and indistinct due to the great number of fibers and their influence on each other. The theory of elasticity of nerves is discarded with contempt and a few well-chosen, simple experiments are given to show that it could not possibly cause muscular contraction. Monro does not seem to believe in the fluid-conductivity theory and yet this seems the most plausible to him of any advanced. He admits that he cannot cause swelling of the nerves by pumping fluid in and that he can get no fluid out; but there may be vessels so minute as to be invisible and the fluid there in very small quantity. There are many reasons set forth for the acceptance of the fluid theory. When the phrenics are exposed and the fingers strip them, a muscular contraction of the diaphragm results. If the fingers are held tight on the nerve below the place of stripping, no contraction results. Does this not prove that there is a fluid in vibration? However, a tangle results when considering motion and sensation in the same nerve. Thus the theory of "arterious" and "venous" nerves is advanced. Disease is caused by the quantity of fluid in the nerves being above or below normal.

> The nervous fluid moves constantly, equally and slowly, unless when its course is altered by the influence of the mind, or by the pressure of some neighboring active organ. This fluid is manufactured in the brain, its gland. It is also nourishing—thus atrophy of a part results on cutting its nerve supply and the brain of a child is large in proportion to assure rapid growth.[10] . . . Too strong application of objects gives pain for the objects of our senses all act, and the organs are all impressed in nearly the same way.

From this it would seem that function was a matter of degree. But later it is said that each organ has its proper object or stimulus:

> If the object is changed we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye, to give us any idea of colors; yet when all light is excluded from the eyes, an idea of light and colors may be excited in us by coughing, sneezing, rubbing or striking the eyeball. A cane vibrating, so as not to excite sound perceptible to the ear, applied to the teeth, raises a strong idea of sound.[10]

This is remarkable like the law of specific nerve energies advanced by Johannes Müller in 1850.

In muscular contraction, "the nervous fluid flowing constantly into the muscular fibrils, by enlarging their transverse diameters and shortening their axes" causes the entire muscle to shorten. If there is not enough fluid, paralysis results, if too much, convulsions; if the motion of the fluid is not uniform, palsy and tremors.

There are forty pairs of nerves, ten pairs of cranial, the first seven being as we describe them now, the eighth the vagus, the ninth the glossopharyngeal and the tenth the accessory.

The third of Monro's great works is on the nutrition of fetuses.[11] At the time of writing, embryology was in the elementary state and the whole argument is as to whether nutriment enough, in the form of liquors passing through the placenta, both to and from the fetus, is enough to nourish it or if also the amniotic fluid is taken in through the mouth.

On fetal circulation: The extremities of the umbilical vein take up the liquors by absorption in the same way as the lacteal vessels do in the guts and the umbilical arteries pour their liquors into the large cavities of the sinuses or other cavities analogous to them. By injecting both oil and quicksilver into the vessels of the womb and none ever being recovered in the fetal vessels, it is thought that the fetal and maternal vessels do not communicate directly. There have been cases, we are told, where fetuses have lived in the womb seven days after the umbilicus has degenerated. The reasons for not thinking the amniotic fluid was used for food are: (a) It contains little nutriment; (b) It is never found in the fetal stomach; (c) If there is a decrease in it at birth, this is so that the uterus is not over distended; (d) No water can be made to pass back of the root of the tongue of the fetus; (e) The "excrement" found in the bowels of the fetus is found when the fetus has no mouth; (f) Chicks open their mouths in the fluid and yet the fluid does not decrease in amount and none is found in the crop. Wm. Harvey used the latter fact in endeavoring to prove that the amniotic fluid is swallowed by the fetus.

Monro was very much interested in aneurysms and with Monro II dissected all that he could obtain. He considered them due to disease of the internal layers with sudden stress at that point.[13] Aneurysms, it seems, were often brought about by unskilled use of the lancet in bloodletting through injury to the vessels.[11] The only cure for aneurysm was ligation or cutting out the aneurysm following this with ligation.[15]

In his works, manifest interest with little understanding of tumors is discerned. All tumors possible are dissected and discussed. Thus there are white swellings of the knee[16] (possibly a chondroma), osteoma of the knee,[17] an anomalous tumor of the leg[18] (possibly sarcoma), cancer of the breast,[21] and some sort of tumor of the nose.[30] The operations performed for these, as for other diseases, were usually fatal due to the shock and sepsis. In speaking of cancer of the breast, he says:

> Of near fifty cancers, which I have been present at the extirpation of, only four patients remained free of the disease for two years. Three of the people had occult cancers in the breast, and the fourth had an ulcerated cancer of the hip. The disease does not always return to the part where the former tumor was taken away; but more frequently in the neighborhood and sometimes at a considerable distance. Upon a relapse, the disease in those I saw was more violent, and made much quicker progress than it did in others on whom no operation had been performed.[21]

Ulcers also were a favorite topic. An ulcer was merely an ulcer and not an effect resulting from some cause. In an ulcer of the leg, amputation was frequently practiced.[19] On amputation, he says, apparently to students:

> In the operations of surgery, there are a number of little circumstances, several of which seem at first view to be attended to in practice, that are bound to contribute considerably to a speedy or tedious cure, to bring on or prevent bad symptoms, to keep the patient easy, and preserve him, or to put him to pain, and bring him into danger.

The operation is performed so as to bring about a "safe and early cure." The patient, during the operation, is described as being faint with pain and is roused at the end by a cordial, when fresh hemorrhages are looked for. The revolution against bloodletting was begun by such statements as, "Hemorrhages after amputations seldom require blood-letting; nay, that the common practice is pernicious in most such cases." In amputations the dressings were changed when the patient was sensible of an uneasy itching in the wound.[20]

Ulcers of the lung are described as "so frequently fatal that some of the ablest physicians make it a question, whether ever a consumption from that cause has been cured." Bloodletting was practiced, but with little success.[22]

There is a peculiar case of an ulcer of the cheek where the superior salivary duct empties to the outside. Monro called in his friend, the great surgeon Cheselden, who obtained a cure of the ulcer by causing the duct to empty into the mouth.[28]

Although he was not a surgeon, Monro was greatly interested in surgery. He attended many operations and advanced many new ideas in surgery, instruments and dressings. Thus there was proposed a new method of abdominal paracentesis or tapping of the belly in dropsy by which an opening was made and a belt used to keep a continuous flow. This seems to be a forerunner of the drain.[24] At this time surgery was advancing fast, as witnessed by the introduction of the curved scissors, hemostatic needle holder, toothed forceps, a new instrument for pulling teeth, bolsters for hernia, an instrument for opening fistulae, a steel grooved catheter for lithotomy, a new type of aneurysm needle and a chisel for cutting off fingers and toes.[35]

Quite a little interest in hernia is found throughout his works.

> The viscera of the abdomen cannot fall down through the rings of the muscles to form a true hernia in the groin or scrotum, unless the tense peritoneum covering these rings is either broken or stretched.[33] . . . What I would recommend then is to examine accurately the circumstances of the disease; and to vary the method of cure according to the nature of the obstacle to reduction, whether it is air, feces, increased growth of parts, or overstretched inflamed vessels.[33]

Operations were not encouraged unless there had been strangulation but it is held that operations for hernia are safe. The belief that they were not safe was due to operations by blunderers some years before. False or scrotal hernias are held to be quite important and are divided into haematocele, pneumatocele or windy tumor of the scrotum, varicocele, spermatocele and sarcocele. Castration is resorted to only after all else fails.[34]

Monro, as all anatomists, loved to dissect, and especially the unusual. Among his dissections are found such as the lacteal sac and duct,[8] a cataractous eye,[25] four cases of "tumefied ovarium,"[26] and the spermatic vessels and scrotum with its contents, proving the continuity of the vas deferens and epididymus.[32B] Many complete autopsies were performed.[32A] The duodenum is carefully dissected and described.[39] It is believed that the mucus secreted in the intestines protects the mucosa from the action of digestive juices. The appendix is assigned the function of lubricating the colon with mucus and this probably kept surgeons for a long time from realizing that inflammation thereof was dangerous. It was noted that the glandulae venales (suprarenals) and the thymus became smaller later in life, but this was ascribed to increase in pressure on them.[40] The lungs and pleura are considered contiguous as was first advanced by Lieberkühn and Haller on animals. Monro, however, believes there are different organs of inspiration and expiration and he asks, "Would not the pressure on the same part of the lungs during inspiration be nearly as much less than the weight of the atmosphere, as is the weight raised in expiration; since it is the same glottis which allows the air to pass in both cases?"[48]

Monro believed that advance in medicine was benefited greatly by the publication of rare or peculiar cases and their treatments. Two of the cases are of his own illness, first of an angina which he did not understand[36] and secondly his method of mending his "fractured Tendo Achilles."[49] Much confidence is not placed in these observations for he says: "We all have a common frailty of enlarging on our own misfortunes."

Tumors in the mouth are often mentioned but it seems that often these are merely abscessed teeth, for when they are drawn and the mouth washed with brandy, a cure is brought about. In referring to these one reads: "The tumor was as large as a small golf ball"; from this one would judge that Monro was not a golf enthusiast as golf balls have always been of uniform size.[27] One pities him when he says in regard to a case of procidentio uteri in a child: "I several times considered amputation; but, being sensible of the body of the uterus being to be cut through, and frightened by the ill success of Ruysch and some others in this operation, I had not courage enough to undertake it."[31] The patient died. The peculiarities of medical reasoning of the day are shown well in a case of asthma, or as we would have called this case "brown induration of the lungs." There was a cardiac ailment and so applications were made to the chest. Compensation took place and the recovery was ascribed to the potency of the medicaments. [37]

Monro understood well the formation of gallstones but thought most cases of icterus were caused by compression of the ductus choledochus.[38] Many cases are discussed which have been cured empirically without knowledge of the ailment.[41,43,44] Peruvian bark is recommended in almost all cases as "an excellent assistant to nature."[44] It is also believed that if the patient be allowed to continue his regular habits, a cure is more likely, due to the peace of mind.[42] Many cases of intestinal disturbances are cited. It is believed that when substances are swallowed, in most cases they take on a "crust" and obstruct the intestine.[50] Procidentiae ani, intussusception, inflammation and volvulus of the intestine resulted in death in all the cases given. The lack of faith in intestinal surgery is shown in the statement: "Nor do I believe any will be so hardy as to advise the amputation of the affected part of the gut."[51]

Monro was called upon to answer some questions in regard to smallpox in Scotland and this constitutes one of his best known works. The account is addressed to "The most worthy dean, and learned delegates, of the faculty of medicine at Paris, appointed to inquire into the advantages and disadvantages from innoculation of the smallpox."[53] 1. Has inoculation been long practiced in your country and with what success? It was first introduced in 1726. There was prejudice against it as it was "deemed a tempting of God's providence."

> The purulent matter employed for inoculation is taken from healthy children from sound parents, then under the distinct, mild, fully suppurated smallpox, and as recent as it can be obtained. A slight scratch is now generally made in the skin of one arm, into which a little piece of small thread passed through pocky matter is put and kept there some days by a bandage,

The success seems to be more or less in producing the pox and in most cases this was accomplished.

2. Did some of the inoculated die? One in seventy-eight of the inoculated died and one in six by the natural smallpox. These figures are due to totals furnished by numerous physicians. Some causes of death advanced are: a. The bad constitution of the patient and improper time of inoculation. b. The bad management of the inoculated. c. The natural, not the artificial, infection being the cause of death. d. Other supervening diseases.

3. Did some who had undergone inoculation take the natural smallpox afterward, and at what time? ". . . They never saw any attacked by the true smallpox after they had the true kind, whether communicated by art or nature."

4. Do you know that other diseases have been ingrafted with the smallpox by inoculation? This is answered negatively.

5. Whether did many, after inoculation, labor under various diseases which seemed to be owing to this operation and whether did this happen more frequently or seldomer than natural smallpox? Many did labor under these diseases but "There are not near so numerous or various bad consequences after inoculation as after smallpox by natural infection."

Cuvier published his comparative anatomy from 1801–1805. Monro published his fifty years before this.[54] In the introduction he says:

> The principal advantages of Comparative Anatomy are the following: First, it furnishes us with a sufficient knowledge of the different parts of animals to prevent our being imposed upon by such authors who have delineated and described several parts from brutes as belonging to the human body. Secondly, it helps us to understand several passages in the ancient writers in medicine who have taken many of their descriptions from brutes and reasoned from them: their reasonings have often been misapplied and consequently wrongly explained by the moderns, through a foolish fondness to support their own inventions, or give an air of antiquity to a favorite hypothesis. The third and great use we reap from this science is the light it casts on several functions in the human economy, about which there have been so many disputes among young anatomists.

Descriptions are given of quadrupeds, herbivorous and carnivorous, fowls granivorous and carnivorous, carnivorous birds and fish. To the thymus and thyroid are ascribed the function of "the separation of a thin lymph for diluting the chyle in the thoracic duct before it be poured into the blood." It is noted that the brain of the fowl is smaller in proportion and simpler than the human brain. In fowls "The membrana tympani is convex externally, and no muscles are fixed to the bones of the ear, which are rather of a cartilaginous consistency. Any tremulous motions impressed on the air are communicated in these creatures merely by the spring or elasticity of these bones." He believes the spleen was particularly designed for preparing the blood for the liver.

A wonderful insight into the character of Monro is derived from a perusal of his epistle to William Hunter.[55] He begins as follows:

> Sir—Disappointments, it seems, must be met with in every stage of life. I had flattered myself that being now in less Hurry of Business than formerly, and having the assistance of my son, I might sometimes enjoy the conversation of my Friends, and pursue as much of the practice of Medicine, as did not require fatigue, but would rather add to the sweets of a calm retreat. It was really cruel of you to force me to resume the Pen, especially in controversy, which I always disliked so much, that I never was the aggressor. You must have been conscious of this, by seeing that I did not claim what of my Performances you assumed to yourself, or published without acknowledging such things ever to have been mentioned by any other person. But your attack in your Medical Commentary on my Candour and Veracity, the part of my Character which I always valued most, piques me so much, that I must appeal to the Public for Redress; and possibly when the spirit is thus roused, something more than my vindication may appear.

The credit Monro is accused not to have given was because the work had not been published. As to misinterpretation of others' works: "On the contrary, I have interpreted his Works in the most favorable way for *his* argument, which is the side I would always prefer, where there is any ambiguity." It appears that in all the arguments, Hunter has personal malice and is trying to pick flaws in his old master. This probably started in Monro refusing to give credit for some discoveries to Hunter as he (Monro) claimed they belonged to Morgagni, Winslow, Haller and Albinus. This so angered Hunter that he wrangled about anything to get even. He ends with advice to Hunter which is not unlike Polonius to Laertes:

> In your publications do not pretend to perfection; for man must err,—Avoid serious Argumentation and a show of learning for, be assured of it, that an examination of either will redound little to your Honor. A joke may sometimes pass for a Demonstration, and if it is of the farcical kind, may please a young audience; but remember that indulging this sort of humor frequently, though one is ever so confident of having smooth, artful, ambiguous words always at command, will create a grudge in the hearts of all good-natured people. You will give less offense by speaking in plain contradiction to those you have occasion to dispute with. When you mention cases of patients be so explicit in their History, that some judgment may be formed of the nature of their diseases. Use your influence not to publish anything relating to you till you have revised and approved it; for at present what they say is believed and held as proceeding from you. This, you know, is giving your adversaries too much advantage.[55]

Alexander Monro II was born May 20, 1733. Having given, at an early period of life, proofs of acuteness of mind, he was placed under a tutor and from him learned Latin and Greek. He was entered at the University of Edinburgh, and passed through the usual course of study prescribed for those who intend entering a profession. He evinced, at an early age, a predilection for anatomy and it was in this department of science which he was most anxious to excel. His ambitions were fostered with great care by his father and the other able professors of the University. He seems to have been well suited for anatomy, "possessing an insatiable thirst for medical knowledge, an uncommon share of perseverance, and a very good memory, seldom forgetting any circumstance of moment which he had observed in nature, heard in conversation, or gleaned from books."[59] During the second year of his medical course he began giving the evening lectures for his father and when only twenty-two years of age, he was appointed Assistant Professor of Anatomy and Surgery on July 12, 1755. As a student he made experiments on the stoppage of blood flow, on the formation of bone, and the dangers of the operation of trepanning. He dissected the testicle in a number of specimens and adduced many arguments to prove that lymphatic vessels exist in every part of the body, and are absorbent vessels. He received his degree in 1755 and then went to London where he attended the lectures of William Hunter. Following this he journeyed to Leyden where he formed an intimate acquaintance with Albinus. He also formed a lasting friendship with Camper. In Berlin he lived with the elder Meckel and it was there that he proposed paracentesis of the thorax in 1757. His return to Edinburgh was hastened by the declining health of his father. At the age of twenty-five years he assumed the position and duties of professor of anatomy. "As a lecturer he is described as being clear, earnest and impressive, and possessed of a fund of medical, surgical, pathological and physiological information and of the ability to impart this information to his hearers."[67] His lectures were always well attended by students from many nations. Monro II never used notes and preserved only the heads of his lectures which he was continually changing. "His life was distinguished by no striking event—it was checkered by no vicissitudes of good and evil; it was a life, from early youth to extreme old age, of almost uniform and uninterrupted prosperity." (From a letter of Dr. James Gregory.)[59] The early writings of Monro II were controversial rather than investigative in nature and it was not until he was fifty years of age that he began to publish the researches and investigations that have served to mark him as a great anatomist. Considering that he was a busy practitioner, indeed, the leading physician of his era, it is remarkable that he found time to extend his researches over such a wide field, embracing, as they did, gross and minute anatomy, comparative anatomy, physiology and pathology.

He was a popular member of the Harveian Society of Edinburgh, a convivial as well as learned society and at its meetings, according to Dr. Duncan, the father of the Royal College of Physicians in Edinburgh, "without transgressing the bounds of the most strict sobriety, he afforded us demonstrative evidence of the exhilarating power of wine."[68] It is said that he laudably lived through the most dangerous of successions, a great father.

Monro II acted as Secretary of the Philosophical Society of Edinburgh during several years. In 1782 this society was incorporated by charter into the Royal Society. He was obliged to resign his office on account of the urgency and multiplicity of his avocations.

> Dr. Monro II was a kind husband and an indulgent parent; and his good offices were not limited to his own family and relations. He was always ready to assist the poor with his purse and professional skill, was a subscriber to all charitable institutions and took an active share in the management of the royal infirmary. In person, he was about middle stature, and of vigorous and athletic form. His shoulders were high and his neck short; his head was large and his forehead full. His features were strongly marked. He had a prominent nose, projecting eyebrows, light blue eyes; rather a large mouth; and a countenance expressive of much intelligence and study.[59]

Monro II lectured until his death from apoplexy, October 2, 1817. He was then eighty-four years old.

Possibly the more logical way to consider the works of Monro II would be in order of importance but as this is a matter of opinion, and opinion differs so greatly, it would perhaps cause less controversy to make the consideration in chronological order. In this way, too, the various influences at work may be better considered.

The graduation thesis of Monro II is written in Latin and is a further extension of the research on the testis, started while a medical student. After discussing the structure of the testis, its tunics, nerve and blood supply, he goes into the question of the connection between the tubules, which was then an unsolved problem. Examination was made by injection with mercury and it was proved that the testicle is composed of a number of tubes, which are nearly of the same size, much convoluted and of great length; that these tubes form a network from which twelve to fourteen straight tubes lead to the epididymis, which he discovered to consist of a single tube. Seminal secretion is discussed in other animals as to production, movement and ejection phenomena and this is compared with the human. It is observed that semen has a close relationship to both blood and lymph.[58]

In the answer to Dr. Akenside,[61] the argument is on the origin of lymphatics. Monro seems to side with Haller in saying that the lymphatics originate from the excretory ducts of glands, from arteries and from veins.

> Dr. Haller and those who defend the system of lymphatic arteries, suppose that Nature, which uses in all its operations the most simple means, chose to blend red blood and lymph together, in order to propel both by the action of the heart; But that, in the extremities of the arteries, the red blood and the lymph are divided from each other, the one to return to the heart by the red veins; and that these liquors are separated from each other by the one's consisting of larger globules than the other; and that therefore these vessels differ only in size, having their liquors circulated in a similar manner.[61]

A vein is defined as a vessel in which "the fluid moves from the smaller to the larger branches and toward the heart" and thus lymphatics are veins.

The Monro-Hunter quarrels lasted over almost two generations. As has been seen, Monro I taught William Hunter and then got into controversy with him late in the life of the former. This family matter was continued ably by Monro II. In his Observations, anatomical and physiological, 1758 (which I have not been able to obtain), he goes into many of Dr. Hunter's supposed discoveries and discounts them as being modifications of those of others. Throughout the entire works of Secundus, scorn is shown for any of either of the two Hunters' work. Since William Hewson was the partner of William Hunter, he also came into the quarrel. Hewson, who was a student of Monro II, published on paracentesis of the thorax and on the lymph vessels as absorbents. Monro II refutes the originality of these investigations with adequate proof. Paracentesis of the thorax was performed by him with Meckel in Berlin in 1757. He studied lymphatics by blowing them up and injecting mercury into them. With irrefutable evidence it is shown that in 1760, Monro II had said in his lectures: "Lymphatics are certainly absorbents; red veins very improbably so." Figures are given which were used to show the independence of the lymphatic and circulating systems. There seems to have been a remarkable change in heart between 1758 and 1760. Now Monro II goes so far as to say that practically all absorption is through the lymphatics in opposition to the view of John Hunter, who thought that absorption also took place in absorbent branches of veins.[64]

Although Monro II was primarily an anatomist, he did much work in nervous physiology and his nervous anatomy seems bound up with it. The remarks on the circulation of the blood in the brain are worthy of note. The prevailing notion of this time was that one-half of the blood of the body was sent to the brain; but by measuring the size of the vessels, this is refuted and it is shown that no more than one-tenth is sent there. The function of the sinuses is to bear increased pressure caused by sudden inspiration or neck movements, so as to protect the small veins of the brain from rupture. Criminal execution was largely by hanging, and it was held that death was due to increased pressure on the vessels of the brain, but it is clearly shown that in most cases, it is due to stoppage of respiration.[63] There is considered here the communication of the lateral ventricles with each other (foramen of Monro) and with the third ventricle, but this discovery was given to the world in a paper almost twenty years earlier (1764). There is denied communication between the fourth ventricle and spinal canal for on opening one he was unable to get drainage of the other. It is believed that there is a lymph drainage of the brain but it is so minute that so far it has remained unobserved. It was generally thought that all nerves originated from the under part of the brain and cerebellum but the theory is advanced that the brain is merely connected to the nerves and not their origin and that there is an energy of nerves, independent of the energy of the brain. Monro II errs in thinking that the spinal cord contains a layer of cineritious or gray matter on the outside of the medullary or white matter. It is peculiar that Monro II should have left the following statement to which Sir Charles Bell gives all credit for his discovery of nerve function: "When we break the cellular substance which connects the two bundles, it will be found that the posterior bundle only ends in the ganglion; and that the posterior bundle has not its nervous fibres incorporated with those of the anterior bundle till it has passed through the ganglion." Peculiar because Monro II should have made the discovery. Credit must also be given for: "Unless I am much deceived, I have seen in man, an intermixture and partial decussation of the cords which compose the optic nerves," and "I have discovered, in the ear, that the branches of the portio mollis form, upon the membrane and scala of the cochlea, a most elegant plexus."[63] Correction is made of the courses of many nerves and as to the extent of the retina.

In nervous physiology, some remarkable assertions were made. Although Waller, in 1852, described degeneration, in 1783[63] Monro II said: "I have found in frogs that, although the divided parts grow together again, the influence of the nerve beyond the incision is generally not recovered." It is admitted that the nature of nervous energy is not known but in 1792,[60] he endeavored to find this out by using Galvani's couple (tin-foil and silver). It was shown that stimulation, in this way, of the nerve caused muscular contraction but it was wrongly thought that this may also be obtained if a tight ligature is put around the nerve or if the nerve is cut and the ends brought together. In short, Monro II thought there was a difference between normal nerve impulses and nerves stimulated in this way for he says: "We seem therefore to be led to the conclusion, that the matter of fluid which is excited or put in motion by the application of the different metals to each other, and to the nerve, serves merely as a powerful stimulus to that energy or fluid which is lodged in the nerves."[60] He realized, however, "that the nerve of a living animal, whether entire or cut and rejointed, conducts that matter by which the muscle is influenced, more readily than the skin, flesh, or the blood vessels."[60]

Even before these experiments (1783), he did not believe that nerves carried nutriment and he explained atrophy of a palsied limb as being due to lack of nourishment, the nerve supply to the blood vessels being cut.[63]

On injecting opium under the skin, it was found that other nerves of the body were not affected if the blood vessels from this part were ligated, "which proves that the arteries accompanying the nerves, or the arteries of the pia mater of the nerves, have great effect in fitting the nerves to receive and to communicate impressions."[63]

In hydrocephalus, it is thought that parts of the brain are carried away by absorption.

Puncture is advised for external hydrocephalus but not for internal hydrocephalus.[66]

As to the eye, the lens is shown not to be muscular and to have refractive power far above that ordinarily supposed. It is claimed that no part of the body has so much nerve supply for its weight as the iris. The sphincter muscle of the iris is emphasized and drawn, even though its existence is denied by Zinn, Haller and Wrisberg. As to function, it is stated that "the iris by lessening the pupil and intercepting the most divergent rays of light, renders the picture of near objects more distinct." The recti and oblique muscles were supposed to change the position of the lens and retina with regard to each other; the orbicularis palpebrum to make the cornea more convex.[66]

In the "Structure and Physiology of Fishes,"[65] much care has been exercised to compare the various parts of the fish with man and from observations, to draw certain conclusions as to structures not definitely worked out on the human. More work is brought out on the lymphatic system. "I have discovered numberless lymphatics in their (nantes pinnati) brain, eye, ear, nose; in all which places the existence of lymphatic vessels has of late been called in question by men of eminence." It was found that lymphatics could not be injected from arteries. The movement of lymph is attributed to the muscular walls of the vessels. There is an argument with Hewson on the spleen. Hewson found a difference in the red particle content of the blood going to and coming from the spleen and therefore said that the spleen completed the red particles. Monro II saw no difference in the red corpuscle content of the two streams. Some experiments are described on hearing and it is decided that water conducts sound faster and better than air. The conduction of sound is mentioned but not very clearly exposed. The cochlear nerve (Portio mollis) is traced and in this a controversy with Scarpa is started as to the course. The latter claimed that all branches were conducted by the lamina spiralis but Monro II denies this and brings forth attestations to his dissections demonstrating this fact.[66] It is claimed "that the nerves terminate on the inner sides of the osseus gyri, in a demi-pellucid, soft, pulpy membrane, resembling the retina of the eye."[66] Fluid was found in the canals but no function attributed to it.[65] Very minute dissections of fish are represented in beautiful copper plates. Camper greatly admired this work and translated it into German.

Probably the best known of all of Monro II's works is his work on bursa.[57] He states that the subject has been overlooked and as evidence of his skill in dissection and observation, describes 140 bursae (33 in each superior and 37 in each inferior extremity). The structure of the bursae is described microscopically and macroscopically and there is shown similarity in organization to capsular ligaments and joints. The common belief was that the synovial fluid was secreted by the fat pads of the joints. "There are no holes or ducts of considerable size leading from the spherical bags containing fat globules" but due to the greasy feel of fatty things, he embraces the view that the pads do secrete. There is a section "Of the cause of the Dangerous Inflammation which generally follows the wound of a shut sac and of the manner of preventing it," which is of great historical interest. Pasteur in 1857 worked out his famous "Theorie des Germes," confirming the supposition that putrefactive processes were the result of germ infection, and showing that a sterile solution remained sterile if protected from accidental air infection. Ten years later, in 1867, Lister developed the practical application of this doctrine. Eighty years before Lister, however, Monro II emphatically states his opinion to be that the danger of infection lies in exposure to air. He may not have understood the reason of infection but he appreciated that exposure of a joint, or the peritoneal cavity, to the air was followed by a fatal inflammation in the majority of cases. He knew nothing of germ life. Inflammation was believed to be a sequitus to exposure.[69] Nothing can be so pernicious as opening a (hernial) sac; the bowels ought to be returned without exposing them to the air.[57] In hernia the tendon is cut and the bowels reduced by pressure. Peritonitis is believed due to air escaping from the colon into the peritoneum.

As to the oblique fibers in muscles, Monro II says: "The number of fibres may be so much increased by their obliquity, as to do more than compensate for the loss of force occasioned by it."[62] The oblique fibers "perform much more extensive motions with the same degree of shortening, the extent of motion increasing with the obliquity." "As the obliquity of an oblique muscle is gradually increasing during its action its force is diminishing; while its effect of producing extensive motion is increased." It is also proved that where two oblique muscles balance each other, the motion of their insertion is more extensive than can be produced by two straight muscles of the same length. Both layers of intercostals are supposed to cooperate as muscles of inspiration. There are two layers "to render the motion of the ribs upward as direct as possible, and to prevent it from being drawn or pressed forwards or backwards so much by its friction to interrupt the freedom of its motion."[62]

In a description of a monster born without head or arms, and deformed as to legs, Monro II says:

> As to the nervous system, we find in this monster, not only the existence and common appearance of the spinal marrow and nerves connected with it, although the brain and cerebellum are wanting; but we have proof that these, independent of the brain and cerebellum, may actuate the muscular fibres in the vessels of an animal, or that nervous energy, or fluid, as it is commonly called, is not derived from the brain and cerebellum solely; that is, we conclude that the nerves, as well as the brain and cerebellum, are capable of furnishing nervous energy; and that there is no more reason for believing that the nerves are derived from the brain, than that the brain is derived from the nerves; or all the parts and branches of the nervous system appear to possess the general power or office of furnishing energy.[67]

A few of Monro secundus' ideas gleaned from his lectures will not, I presume, be amiss.[59] The purpose of the lymph glands is believed to be to take poisons out of the lymph. Therefore, extirpation of buboes is not advised. As to cause of inflammation: "The appearance of the inflammation varies according to the nature of the infection." The dilatation of arteries in the region of the inflammation being held due to stronger heart beat rather than to relaxation of vascular musculature. In the organization of a thrombus the vessels are claimed to be extensions from the original vessels and not "the coagulum which forms the vessels in and of itself," as John Hunter describes. Pus is considered not a conversion but a new secretion. To cure inflammation the following treatment is resorted to: (a) bleeding to lessen the force of the blood; (b) pressure on the artery to the inflamed part; (c) purgatives; (d) a blister applied near the part; (e) rest; (f) a cooling and spare diet; (g) external application of opium to the part.

As to respiration, "the internal surface of the air-cells is nearly thirty times greater than that of the whole external surface of the body. . . . There are 512,000 air cells per cubic inch."[59] Asthma is attributed to spasm of the transverse and oblique arytenoid muscles of the larynx. For empyema, paracentesis of the thorax is advised, an incision being made. By this means, it is claimed, recovery results, for "the lungs were as much compressed by the matter, as they are by the air which is admitted; and generally they are supported in different places by partial adhesions of the lungs to the containing parts of the chest."[59]

On the circulation, it was believed that the blood was circulated "by the conjunct agency of the heart and the coats of the arteries and veins." The ligature is favored in hemorrhage, but it is advised that but one knot be tied, so that the ligature may be tightened at will. Ligature of an aneurysm is preferred over amputation.

The view of life which Monro II took is beautifully brought out in the following statement as to the mechanism of some unlearned muscular actions:

> When we throw into the scale the various effects of what has been commonly called instinct of animals, does it not appear, that the most just as well as the most becoming conclusion we can draw is, that the Power which created all things, which gave life to animals and motion to the heavenly bodies, continues to act upon and maintain all, by the increasing influence of a living principle prevailing the universe, the nature of which our faculties are incapable of duly comprehending.[63]

Alexander Monro III was born in Edinburgh, November 5, 1773. He was educated at the high school there and then took the regular university course. This was followed by the medical course and he obtained his M.D. He then journeyed to London and studied anatomy and surgery under the famous Wilson. After that he stayed a short while in Paris, after which he returned home. In 1800, at the age of twenty-seven, he was appointed conjointly with his father at whose death in 1817, he became sole professor of anatomy and surgery. He continued in this office for almost thirty years, resigning in 1846. Among his pupils were Professors Alison, Traill, Christison, Syme, Liston, Miller, Edward Forbes, etc. and Doctors Abercrombie, Hope, Holland, Bright, Marshall Hall and Sir Humphry Davy. Monro III was married twice, first in 1800, to the eldest daughter of Dr. Carmichael Symth by whom he had six sons and six daughters; second in 1836, to a daughter of David Hunter, Esq. of London. He died at Craiglockhart, near Edinburgh, March 10, 1859.

It seems advisable to consider his works also in chronological order, remembering that it was possible for him to get personal assistance from his father until his death in 1817, remembering also that Monro secundus' last work and Monro tertius' first work both appeared in 1797. It must in all justice to Monro II be remarked that none of his truly great works appeared before the death of Monro I.

The graduation thesis of Monro III, written in Latin, appeared in 1797 and was on dysphagia.[72] In it the esophagus is fully discussed anatomically but no new ideas are advanced. The various possible causes of dysphagia are gone into in some detail. In the treatment, very little progress has been made since this book was written except the invention of more suitable instruments and the use of anesthesia. John Hunter's treatment of dysphagia is given but discarded for that of Monro II, upholding the family tradition. Willis and Hunter are quoted quite frequently but by far the most dominant authority is "pater meus." The book shows very little or no original work and is largely a collection of the opinions of others on the various causes and their treatment. There is one great value to this little work, however, and that is that it establishes priority in the invention of the stomach tube. It is often claimed that Dr. Philip Physick (1768–1837) invented this most useful instrument. Dr. Physick was a student of Monro II and graduated from the University of Edinburgh in 1792. His only claim to the stomach tube is that he was the first American to wash out the stomach with it in a case of poisoning.[56] Monro II invented the original stomach tube, a description of which follows:

> This tube is to be composed of an iron wire, much larger than a common stocking wire, or about one-tenth part of an inch in diameter. In order to give it the cylindrical form, it is to be twisted around a thick rod of iron; and, after taking it off the rod around which it was turned, it is to be covered with smooth leather.
>
> To the end of the tube, which is intended to be passed into the stomach, a brazen pipe, two inches long, of the same size as the tube, and pierced with a number of holes, is to be firmly connected.
>
> To prevent the tube from bending too much

within the mouth or gullet, in time of passing it down into the stomach, an iron wire one-eighth of an inch in diameter, and of the same length as the tube, is put within it, which is to be withdrawn when the tube has entered the stomach.[73]

This account was first printed in an English newspaper in an account of the cure of an ox with constriction of the esophagus. Later, however, Monro II used it to feed soup to a man having a cancerous stricture of the esophagus.[74]

In 567 pages, Monro III tells us the morbid anatomy of the digestive tract.[74] The "brevity" of this work, of course, carries with it certain curtailments. "It is the object of Morbid Anatomy to classify and explain all deviations from the healthy structure and the symptoms connected with organic derangements." The book is divided into five parts. The first two are on organic diseases of the alimentary tract. In diseases of the coats of the alimentary tract alone, over one hundred "deviations from the normal" are discussed as to symptoms, treatment and results thereof, many cases of each and the opinions of practically every one who had one are given on each subject. There is a long discussion of hydatids, which are defined as "a round or oval-shaped, semi-opaque pulpy bag, possessing a contractile power, without an external opening, or a pearly or yellowish color, containing a watery fluid, and often a number of smaller hydatids, and included within its proper capsule or cyst." Seven different kinds of hydatids are mentioned and much detail is given concerning each.

In regard to tuberculosis of the alimentary tract: "This disease attacks children, and also those in the meridian of life; whereas, the aged more frequently suffer from cancer."

The third part of the book is on obstruction originating from a displacement of a portion of the alimentary tract and this gives opportunity for two hundred pages on hernia. As to production of hernia:

> There being a constant action and reaction between the contained and containing parts, those causes which diminish the resistance of the containing, or increase the pressure of the contained parts, may give rise to Hernia . . . In every species of Hernia, the prognosis is unfavorable, in so far, at least, as relates to the complete recovery of the patient.

Death is due either to strangulation or the operation for the hernia. The hernias described are inguinal, crural or femoral, umbilical and congenital ("a modification of the inguinal or scrotal hernia and appears at or soon after birth").

The fourth part is of malconformations of the lower part of the intestinal canal and the fifth on the worms which infest that passage. Monro III concludes with: "I have, with a very few exceptions, aspired merely to be the faithful recorder of facts, being fully persuaded that in science, as in architecture, it is necessary to collect materials before we proceed to combine them" He does not mention, however, that all these facts are those of others.

"I had no preconceived opinion to support, no favorite hypothesis to influence my researches, or to induce me to disguise appearances and bend them to the service of a system."

He states further that he realizes how poorly written and arranged the book is, but he hopes that it will, at any rate, prove some help to the healing art. As for further purpose of writing (which appears in other works of his):

> Another consideration, though more strictly personal to myself, will, I trust, be allowed to be a laudable one. As a Professor of this University, I am anxious to convince the Public, and especially those Friends and Patrons who placed me in that honorable situation, that I have not been inattentive to the obligations which it imposed on me; and, that, in this instance, as in many others, I have been ambitious of treading, though with unequal powers, in the footsteps of my Father and Grandfather, who, for many years, filled the chair I now hold, with credit to themselves, and advantage to their country.[74]

This work cannot pass without some further word. The important points are left far in the background so that the hobbies of the author (hydatids and hernia), may assume the dominant position. The book is too long and verbose to be used as either a reference or a textbook. As an illustration, if there are five cases of disease A on record and five million of disease B, of disease A all five cases are given and a long discussion, while of disease B, no cases are given and there is found only a remark in passing. The anatomical descriptions seem to try to give the reader an impression of the great knowledge of the author, without making anything clear; the cases given are very seldom his own, usually his father's, although others are given. The author's father-in-law, Dr. Carmichael Smyth, is much quoted and great weight laid on his opinions. The book would have been a great deal more useful in a hundred pages, than in the number in which it appears.

Verbosity most certainly had its exponent in Monro III. His work on smallpox is 300 pages in length.[75] The purpose of this book is to encourage smallpox vaccination, even after cases of smallpox appeared in his own family after vaccination. The plea is for legislative action forcing vaccination and the hygienic principles laid down by Dr. Carmichael Smyth. In the introduction, the following two very varied statements are made:

> It is neither wise, nor politic, nor humane to encourage the continuance of the practice, [inoculation] a practice of which the inoculated reap the whole benefit, at a heavy and indeed incalculable expense of suffering to others.
>
> It is not possible to look for or to conceive a milder or more certain antidote to small pox than vaccination, it has a strong claim to the attention of all those who regard the health and lives of their children and of their posterity, the safety of their friends and neighbors, or the good of the community at large.[75]

It is interesting that:

> At the period the inoculation for small pox was introduced, it was objected to it, that a man had no right to submit to the inoculation of a poison by which he might lose his life; if he did so he was guilty of suicide; and if the father consented to the inoculation of his child, if death followed, he was privy to the death of the child.

A history of smallpox is given dating back more than 1000 years B.C. As to its history in Scotland, the work of Monro I[53] is quoted. In speaking of the causes of the disease, he is forced to admit that "very little has been discovered respecting the nature of the contagion." A long account is given of the symptoms and treatment of true and inoculated smallpox, the points where they differed and the possibility of recurrence. He avers "that those I vaccinated (cow pox) did not take the small pox, though they lay in the same bed with their brothers or sisters with the confluent small pox." Statistics are quoted to prove that vaccination saves more lives than inoculation. About one in every two hundred vaccinated get the smallpox and this is claimed to be due to the inefficiency of the vaccine. Case after case of smallpox is given, many exactly alike.

> The most striking difference beween the common cause small pox, and the small pox which follows perfect vaccination, consists in the disease passing with unusual rapidity and mildness through its later stages, when in the common casual small pox, life is in danger. . . .
>
> The events therefore so far from militating against Dr. Jenner's discovery, have proved, in the clearest manner, its incalculable value, and may be said to have confirmed the triumph of vaccination.

His plan for rendering smallpox extinct consists of: (1) Prohibition of inoculation of smallpox; (2) Only those having had smallpox can frequent persons having the disease; (3) Confinement of persons having smallpox and fumigation of their effects; (4) Encouragement of vaccination; (5) Parliamentary aid in enforcing the above.

This book certainly is no exception to the author's style. The material is poorly organized, poorly presented and mixed with too many digressions. Most facts presented seem to be those of others except a few cases which the author personally attended. The plan for rendering smallpox extinct is original but not remarkable.

On hydrocephalus[73]:

> It has not been determined whether or not the effusion of water into the ventricles of the brain, be the original disease and cause of the symptoms, or is generally the consequence of a low degree of inflammation of the Brain itself, or of its bloodvessels, not far removed from inflammation.

On analysis, little difference is found in normal and hydrocephalic fluid. Agreement is voiced with Monro II that there is no communication between the fourth ventricle and the spinal canal because in hydrocephalus no swelling of the latter is evidenced. Hydrocephalus is divided into chronic (extending over a number of years) and acute (rapidly fatal). Many cases are cited of each but the autopsy records given are very incomplete. When tumors occur in the brain, "the patients died with symptoms of hydrocephalus." But usually after denoting hydrocephalus as the cause of death, we learn that "the other viscera were not examined." The tumor is merely present when the patient dies of hydrocephalus.

In one part Monro III says:

> The gait of the patient is peculiar; he totters and cannot walk with his usual firmness, one side of the body being weaker than the other; he lifts his legs very high, and takes long steps of unequal length. This is a bad symptom and generally connected with disease at the base of the brain.[73]

He has almost accidentally hit on the function of the cerebellum, which remained practically unknown until the work of Luciani in 1882.

The opinion is advanced that hydrocephalus is not due to infection as it occurs too early in life and if it was, it could be more easily cured. And alas, he has deserted the ranks of the sacred Monros and agrees with John Hunter that the pia mater never shows marks of inflammation. He also claims that "Hydrocephalus more frequently originates from debility than inflammation." Puncture, as treatment, is not encouraged. The only treatment which at all succeeds is with mercury and the use of purgatives.

Two hundred pages are wasted on this worthless, nay worse—misleading, piece of work. Most of the cases are again quotations, as are the theories advanced. Many unnecessary data are given so that it will appear that the author is well acquainted with the subject.

The exposition on the anatomy of the brain[70] gives Monro III good opportunity to advance many unfounded theories. "The principal functions of the brain," he says, "are sensation, voluntary motion and the various manifestations of mind." It is claimed that "a considerable portion of the upper part of the hemispheres, or of the middle lobes, may be removed without giving rise to any peculiar symptoms." We wonder how peculiar a symptom must be to be considered "peculiar." Again: "The most important portions of the brain on which secreting and assimilating processes chiefly depend, are placed at its base, the place of greatest security, where they are least exposed to suffer from external injury." His idea of importance of the medulla is correct but as to the reason of it, as usual, the guess is wrong. It is said that an injury on the right side of the brain *usually* results in palsy on the left side of the body. Only one tract is mentioned, the optic. Cases of lesions all over the brain are given but these are imperfectly located and the symptoms are not altogether characteristic or complete. Some examples are given:

> Tumor compressing upper part of left hemisphere. Symptoms—Melancholy, drowsiness after dinner, always removed by free exposure to air. . . .
>
> Large osseus tumor compressing anterior and middle lobes of left side. Symptoms—epilepsy. . . .
>
> Tumor embedded in substance of posterior

lobe. Symptoms—Derangement of the functions of stomach and bowels. Double vision, and afterward complete loss of sight.

These are representative of the 102 cases cited and it is astonishing that with so much information at hand, so little was known of localization. This book is shorter and more to the point than any of his works before mentioned.

The last work of Monro III, published when he was seventy years old, is probably his best. It concerns the anatomy of the urinary bladder and perineum of the male.[71] Is the following conceit?

> I indulge the hope that this book will meet with the same flattering reception from the public as the imperfect sketches already published. It is the result of much patient research, and is enriched by the observations of my Father on the Retention and Incontinence of Urine, and sounding, puncturing and cutting into the bladder with the gorget, to which I have added notes.

All that appears to be original is the anatomical description of the parts, which, it must be admitted, is good, although an extensive and excellent account of urinary concretions is given. A typical operation of lithotomy is described. The death rate was 10 per cent. The "cries and struggles of the patient" are referred to, but it is some consolation to think that the year this book was printed, Long discovered the use of the anesthetic properties of ether in surgery. The wound is covered with lint on which cerate is spread. An oiled cloth is then put on to protect the wound from the air. There follows then, an excellent account of the causes of incontinence and retention of urine and the treatment thereof.

The probable reason for the excellency of this book is the fact that Monro II practically contributed the entire work.

In the editing of his father's essays and heads of lectures,[59] Monro III adds many notes which detract from the work considerably. The material is badly arranged and there is twice as much space devoted to notes as to text. On the ear, he says that "the vestibule is undoubtedly the most essential part of the organ of hearing" and the cochlea "receives the vibrations of sound which are propagated through the bones of the head and that by it we are made sensible of the qualities of sound." On the eye, we are told that "the macula is a foramen." On ligatures: "There can be no doubt as to the safety and expediency, in certain cases, of throwing a ligature around the abdominal aorta."

In a postscript, Monro III discusses such closely related subjects as the appearance of arteries in a stump (the preparations by his father and Mr. Spence) and the anatomy of the medulla. He endeavors to apply the Bell-Magendie law to cranial nerves and, as usual, misinterprets. His notes throughout the book are largely quotations from other authorities who have endeavored to improve on the work of his father. It is peculiar, but in most cases, Monro II is right and Monro III is wrong, or the latter has carried logic beyond its reasonable limit.

In conclusion, there is little more to be said. Monro I published any case which seemed to him particularly interesting. Only two of his works were really books and they were not long. He said what he had to say and then concluded by asking a series of questions in which he advanced his theories. His discoveries were chiefly anatomical although he advanced somewhat the practice of medicine through introduction of new instruments and new methods in surgery. Monro II, the greatest of the three, made many researches and performed some of the most crucial experiments known. He is immortal through his discovery of the communication of the lateral ventricles. His fame is also enhanced by his work on paracentesis of the thorax, the stomach tube, the independence of the lymphatic system, the bursae, the action of the oblique fibers of muscles, the separation of the dorsal and ventral roots, and other anatomical subjects. Enough probably has been said of Monro III; how he endeavored through the very voluminosity of his works to rank with his father and grandfather, but it was not to be. None of his works is of permanent value and those written when he was in the prime of life are as confused, prolix and illogical as his senile productions. A basis of notes made by his father and grandfather may be detected throughout and to this he has added only imperfect observations and superficial reading.

As to teaching ability, all were excellent teachers, it is said. Monro primus and secundus alone taught 14,000 students and it must be remembered that primus was the first professor of anatomy at Edinburgh. The classes of Monro tertius were well attended but not so well as his immediate predecessor.

In a few words, the influence of the three Monros on the practice of medicine and surgery was a great one for they contributed much to the adequate education of the physicians and surgeons of a century and a half, besides which they themselves made many important contributions to science.

## BIBLIOGRAPHY

### WORKS OF MONRO I

1. The Art of Injecting the Vessels of Animals.
2. The method of preparing and preserving the parts of animals for anatomical uses.
3. Osteology; or a Treatise on the Anatomy of the Bones, to which are Added a Treatise of the Nerves, etc. Edin., 1726.
4. Description of an uncommon skull.
5. Remarks on the articulation, muscles and luxation of the lower jaw.
6. The mechanism of the cartilage between the true vertebrae.
7. Essay on the caries of bones.
8. Description of the lacteal sac and duct.
9. Cure of lymphatics opened in wounds.
10. Anatomy of the human nerves.
11. Essay on the nutrition of foetuses.
12. Practical corollaries from the preceding essay.
13. On the coats of arteries and their diseases.
14. On the aneurism occasioned by blood-letting.
15. Case of an aneurism.
16. White swelling of the knee.
17. Cartilage of the joint of the knee separated and ossified.
18. Anomalous tumor of the leg unsuccessfully treated.
19. History of an ulcer of the leg.
20. On amputations of the large extremities.
21. Histories of collections of bloody lymph in cancerous breasts.
22. Cure of an ulcer of the lungs by blood-letting.
23. An uncommon dropsy from a steatomatous omentum.
24. Improvements in the operation of tapping.
25. Dissection of a cataractous eye.
26. Cases of the tumefied ovarium.
27. Artificial passages for natural liquors.
28. Cure of an ulcer of the cheek with the superior maxillary duct opened.
29. On the diseases of the lachrymal canals.
30. A tumor of the nose unsuccessfully extirpated.
31. Account of procidentia uteri.
32. (a) The ureters obstructed by small stones.
    (b) Remarks on the spermatic vessels and scrotum with its contents.
33. Remarks on inguinal herniae in men.
34. Of false hernia.
35. A description of several chirurgical instruments.
36. An uncommon angina.
37. An asthma with uncommon symptoms.
38. An essay on the jaundice.
39. Description and uses of the intestinum duodenum.
40. Miscellaneous remarks on the intestines.
41. A tympany.
42. Histories of successful indulgence of bad habits in patients.
43. Unexpected cures.
44. Effects of the bark in gangrenes, ulcers, and small pox.
45. Anomalous appearances of an ague.
46. Remarks on the chalybeate waters.
47. Remarks on the intercostal muscles.
48. Proofs of the contiguity of the lungs and pleura.
49. Cure of a fractured tendo Achilles.
50. Tophaceous concretions in the alimentary canal.
51. Remarks on procidentiae ani, intususceptio, inflammation, and volvulus of the intestines.
52. Child escaping at a rent of the womb into the abdomen.
53. An Account of the Inoculation of Smallpox in Scotland. Edin., 1765.
54. An Essay on Comparative Anatomy. Lond., 1744.
55. An Expostulatory Epistle to William Hunter. Edin., 1762.
56. For biography see GARRISON, F. H. History of Medicine. Ed. 3, Phila., 1921.

### WORKS OF MONRO II

57. A Description of All the "Bursae Mucosae" of the Human Body, etc. Edin., 1788.

58. Diss. inaug., De Tetibus et de Semine in Variis Animal ibus. Edin., 1755.
59. Essays and Heads of Lectures on Anatomy, Physiology, Pathology, and Surgery. With a Memoir of His Life, by His Son. Edin., 1840.
60. Experiments on the Nervous System . . . with a View of Determining the Nature and Effects of Animal Electricity. Edin. & Lond., 1793.
61. Answer to the notes [by M. Akenside] on the postscript to Observations, Anatomical and Physiological. Edin., 1758.
62. Observations on the Muscles and on the Effects of Their Oblique Fibres. Edin., 1794.
63. Observations on the Structure and Functions of the Nervous System. Edin., 1783.
64. A State of Facts concerning the First Proposal of Performing the Paracentesis of the Thorax . . . and concerning the Discovery of the Lymphatic Valvular Absorbent System of Vessels in Oviparous Animals. In Answer to Mr. Hewson. Edin., 1770.
65. The Structure and Physiology of Fishes Explained, and Compared with Those of Man and Other Animals. Edin., 1785.
66. Three Treatises. On the Brain, the Eye, and the Ear. Edin., 1797.
67. Description of a Human Male Monster. Edin., 1794.
68. Dictionary of Biology.
69. For biography see SEELIG, M. B. Life and Works of Monro secundus, *Interstate Med. J.*, St. Louis, xiii, 581.

### WORKS OF MONRO III

70. The Anatomy of the Brain, with Some Observations on Its Functions. Edin., 1831.
71. The Anatomy of the Urinary Bladder and Perinaeum of the Male. Edin., 1842.
72. Disput. inaug.: De Dysphagia. Edin., 1797.
73. The Morbid Anatomy of the Brain. Vol. I. Hydrocephalus. Edin., 1827.
74. The Morbid Anatomy of the Human Gullet, Stomach and Intestines. Edin., 1811.
75. Observations of the Different Kinds of Smallpox, and Especially on That Which Sometimes Follows Vaccination. Edin., 1818.
76. For biography see *Lancet*, Lond., 1859, I, 331.

[Les Sonnets du Docteur.]

# INAUGURAL MEDICAL DEBATE ON ELEPHANTIASIS OR LEPRA ARABUM

## By BENJAMIN NIESIUS, University of Strassbourg, July, 1673

*Translated from the Original Latin and Greek*

*By* Chaplain Benedict Stetter*

*Contributed by* O. E. DENNEY, M.D., D.T.M.*

CARVILLE, LA.

THE rapidly increasing and already voluminous bibliography of leprosy attests the coincident recognition of the present-day importance of the disease; it may not be amiss, therefore, to revive an interesting and ably prepared essay on the subject submitted in 1673 by Benjamin Niesius as his doctoral thesis.

Many of the observations and deductions of Niesius indicate that he had a clear conception of the disease, although it is also evident that other diseases were included in his symptomatology. He recognized as symptoms of incipient leprosy, discoloration of the skin (macules), difficult breathing (involvement of nasal mucous membranes), and numbness and coldness of feet (anesthesia to pain and temperature). As indicative of advancing leprosy, he considered the falling of hair (loss of eyebrows, eyelids and beard), tubercles beneath the skin of forehead and cheeks, venous stasis in the face, flattening of the nose, corrosion of nasal bones, appearance of pustules, conjunctivitis, drying and cracking of hands and feet and extensive ulcerations; a symptom complex applicable to leprosy of the present day.

He was evidently a firm believer in the contagiousness of leprosy "as arising from contact, procreation or miasma and sending filth into another body and thus bringing forth a disease similar to itself."

Niesius observed the disease in parent and child and concluded that the disease was transmitted by heredity; he further noted that occasionally the disease skipped a generation and appeared in grandchildren and described this as a phenomenon of immunity. Much the same views are held today, except that we believe in an hereditary predisposition rather than direct heredity.

He held leprosy to be a disease of adolescence and one affecting males in greater percentage than females. These observations are germane today although our explanations are perhaps no nearer the truth than his.

Niesius recognized fully the importance of correct diagnosis to the patient and physician; a correct diagnosis benefiting the public health, an erroneous diagnosis leading to injustice to the patient and eventual chagrin to the physician.

Prognosis he considered as hopeless but the patient deserving of medical attention; cure, extremely difficult because the disease lies hidden in the body sometimes for a long time before putting forth its strength and violence. Treatment then, as now, was evidently unsatisfactory.

It is to be regretted that no further articles from the pen of Niesius appear to have survived nor has the contributor been able to find further reference to Niesius the physician.

---

*From the U. S. Marine Hospital No. 66 (National Leprosarium).

In the Name of O. Lord J. Chr.

## INAUGURAL MEDICAL DEBATE
## ON
## ELEPHANTIASIS
## OR
## LEPRA ARABUM

which
under the guidance of the Good and Great
God,
by Order and Authority
of the most Noble, Illustrious and
Distinguished
Medical College in the most Flourishing
University of Strassbourg,
for
the Licentiate
of obtaining the Highest Honors in the
Medical Art and Doctorial Privileges
has submitted
to the Solemn Investigation of the Learned
Benjamin Niesius, Frankfurt on the Maine.
July 1673.
Strassbourg
Typ. Johannes Welper.

### Preface

Kind Reader: After my examinations I had been enjoined by the illustrious Professors of the Medical Faculty to write out certain theses and defend them without the President's guidance; there came to my mind a disease which the Greeks call "Elephantiasis," indeed a very serious disease which is not one disease, but rather an Iliad of diseases, arising from manyfold complications of many diseases so that you may call it not unjustly πολυγενὴν καὶ πολύπλοκον [polygenetic and complicated]. I call it very serious on account of its symptoms; for it brings with it a very long series of stubborn diseases. I frankly confess that in rightly [adequately] treating this disease my mental strength has been very little, hence I justly beg the kind Reader to interpret the hallucinations due to human weakness in the most favorable manner.

Honorable Collegium of Doctors
B. C. D.

### §1.

The consensus of the Learned advises a diligent evolution of the name to those who intend to treat this matter on account of various difficulties emerging therefrom; for one will find himself in Cimmerian darkness, if he has not first obtained the most exact knowledge of the name. Hence, following such excellent consensus as well as salutary advice, we shall above all be solicitous about the explanation or definition of the name.

### §2.

First, let us proceed to the Etymology. This disease is called "Elephantiasis" a word which delights in Greek origin; in Latin it is called by the same name, and receives its name from the animal "Elephant." But here it is to be remarked that authors go into various opinions. For, some call this disease "Elephantiasis" because the skin of the sick is similar to the elephant's hide of which opinion Aretaeus approves *lib. 2. method of healing*. Others with Sennertus, *book 5. Prax. cap.* 40, adduce a very improper designation saying that those troubled with this disease become as big as elephants which designation seems to the more sensible Authors not only foolish and absurd, but odious. Platerus calls this disease "Elephantiasis," because the broad and wide ears of the patient somewhat resemble the ears of the elephant. But we accept the former opinion as the more suitable to the nature of the disease, and from which also that of Aetius which he favors in 4. *serm.* I. *cap.* 120, little differs.

### §3.

After the explanation of the correct Etymology let us proceed to the Homonyme which, if not properly examined is usually the cause of many very important controversies. In the writings of physicians there is a twofold acceptance of "Elephantiasis" proper and improper.

As to the improper it is that 1. Elephantiasis of the Arabs which is nothing else but tumor or swelling of the feet. 2. Leprosy of the Greeks which the Arabians called "Albara Nigra"; hence these are incorrectly named by the name "Elephantiasis." In like manner Mercurial, *Book 2 on the "Cure of Diseases" cap. 5*, holds the wrong opinion when he writes that these diseases have one and the same affect. For they differ in cause, accidentals and affected place. To be heard, which is worth them all, is a man, placed above all others, Doctor Melchior Sebizius in his *Specul. Medic. Pract.* who writes that the above improperly call this leprosy and adds that these diseases differ in specie. He who largely treats this doubt *vide L. C. pag.* 3001. Simphorianus Campegius, the most ancient physician, so writes in his treatise on *the kinds of diseases tract. p.* 476.

But it is to be remembered that one kind of disease is meant by the word "Elephantiasis" in the works of the Arabs, another in those of the Greeks. Platerus in his *lecture p.m.* 145 attests that leprosy is erroneously taken for Elephantiasis. The proper acceptance, therefore, is when Elephantiasis represents a universal cancer of our body, which signification we accept.

§4.

Coming to the synonymy where various names given to this disease must be explained. They are taken from a triple source of languages: Greek, Latin and German. As to the Greek names it is called ἔλεξασ, ἐλεξαντία, ἐλεξαντίασισ, Σατυξίαστσ, λεοντίαστσ, ἠγάκλειονπάϑθσ. In Latin it is called "Lepra," universal cancer, not of the Greeks, but of the Arabs. In German "*der Aussatz, Maltzey, Feldseuche* or *Feldsucht.*" For these names the Authors mention various reasons. Why it is called Elephantiasis has been sufficiently explained in the Etymology, as I hope. Why it is called Σατυρίασισ the Authors say that the reason of this name is principally because those suffering from it are wonderfully inclined to sexual intercourse, because the *facultas expultrix* is aroused by the sharp or acid matter which, when excited, tends to excretion. The Authors call it λεοντίασιν, either 1. on account of the resemblance of the wrinkles of the forehead to lions or 2. because this disease affects also lions, 3. ἠλάκλειον πάϑθσ, because this disease, as it becomes visible in the body, becomes invincible and insuperable. The Latins call it "Lepra" on account of small scales falling from the patient. They call it universal cancer because it attacks the whole body. It is called "*die Maltzey*" doubtlessly on account of the badness of the urine, "*Die Feldseuche*" because the sick were forced to live outside the camp, what also Holy Scripture confirms. Some Authors call it the disease of Lazarus, but in Holy Scripture nothing that expressly refers to this is mentioned, hence it will be wrong to hold this for certain.

§5.

Having therefore considered and properly discussed these things we shall be able to arrive more easily at the definition of this disease. For if we had disregarded this, we should advance on a very thorny way and drive at very little; but having already taken this road and set up these things which could very much check our course, let us hasten to the definition of the disease.

§6.

As many as have searched into the essence of this disease, as various definitions they have given to the Medical World. It has pleased some to define this state of body by the cancer on account of its resemblance, others by those dreadful symptoms by which it spreads about, surrounded, as it were, with an innumerable escort. Varandaeus defines this disease by a dry and warm intemperies (Dyscrasia), however, we above all others prefer the definitions contained in *Spec. Med. Pract.* namely that Elephantiasis is a very poisonous, contagious, universal disease arising from atribilious humor, surrounded by many symptoms.

§7.

That Elephantiasis is a contagious, poisonous disease is placed above all doubt. For experience as the most certain teacher of things teaches this more than enough. Live together, I ask, and enjoy the hospitality and conversation of such people,—you will clearly perceive the indelible harm therefrom. For secretly does the dangerous poison creep from host to guest by mutual participation of breath, bed, table and drinking vessels. One would certainly tell the truth if he said that Elephantiasis can thrive and live also in a dead man. Hence, those should take care who, from curiosity, place such infected bodies under the anatomic knife. For, if a scorbute, according to Charleton's *treatise on scrobutes p.m.* 26, as the lesser evil can thrive and live after death, justly Elephantiasis as the greater and surrounded by several infectious particles can assert its strength.

§8.

That Elephantiasis is a universal disease is clear from the fact that it attacks the whole body and wages a fatal war against its threefold substance from which it, so to say, depends and is also produced. First of all, the substance is rendered humid, called humors; for these are changed and assume a different nature. Minds as well as bodies, before very pure, very fine and most penetrating, fed from the best part of the blood are rendered somewhat impure, less fine by vitiated blood; hence, we see those suffering from Elephantiasis become torpid and dull as if they had drunk oblivion of agreeable things. However, this would still be bearable, but the enemy goes on and attacks the solid substance of the body and least desists from eating it up. Hence, you will find hardly one of all the parts of the body immune from its more than Scythian fierceness or savageness.

§9.

But it will now be our duty to inquire diligently into the causes of this disease which as a rule call forth such a lerna of evils, and shall divide them into external and one internal. Again we divide the external causes into natural, non-natural, and preternatural. But we shall first examine the internal cause.

§10.

The physicians trace back this cause to black bile [atrabile]. So great is their consensus in the matter and so great their harmony that, as to say it with Plautus, all have advertised their goods according to agreement just like the oil-dealers on Velabrum Street in ancient Rome. But this black bile, writes Fernelius *de part. morb.* is the cause of the most serious [important] symptoms, especially if it is connected with barrenness [sterility] as it is sometimes the case.

§11.

Whence this atrabilious humor comes, the physicians differ among themselves. However, they agree in this, that it comes from the admixture of all humors: but, which of the humors prevails, in this they differ. This controversy has kept the great men busy and has been the apple of contention on account of which so many and prominent physicians busied themselves and have left us various kinds of this plague or pest. Avicenna, a great Arabic physician following Doctor Sennertus *lib. 5 Prax. cap.* 171, enumerates five kinds of this plague. The Honorable Doctor Melchoir Sebizius in *Specul.* mentions that some foreigners have found four kinds of Elephantiasis.

§12.

But truly, although taken for granted that a great abundance of humors, and especially salted ones, are noticed, yet there is another cause to be sought and investigated, no one will deny. However, this cause will beyond all doubt be of a hidden nature, and must be so judged that rightly the famous Apollo is to be celebrated who has ventured to explain this; hence, we must have recourse to that sweet asylum of ignorance and tarry there so long, until those who deny the hidden properties have given us a fuller and plainer knowledge, which, however, they can hardly do in this life, wherefore it would be more profitable for them to have abstained, than to have prostituted their talents.

§13.

We now proceed to hereditary Elephantiasis which, with the maternal blood and semen, is propagated into children by miasms inherent in their first beginnings. But it is peculiar that, although the semen and maternal blood are befouled and contaminated, nevertheless nature strives to perform its actions. So great, says Fernelius, is the efficiency of this generative faculty that directly consisting in impure semen it forms the parts of the body even from an impure matter. It is to be noted: that, although the effect does not immediately answer the miasms, yet it does in no wise remain, what can be seen and concluded from this: if the mother was not yet affected with Elephantiasis but was prone to it, the child will become leprous at the same age as the mother. Platerius has these words on hereditary Elephantiasis: "Sometimes the children remain immune throughout life, but this plague shows itself in the grandchildren for the first time." So much about the internal cause.

§14.

Next, the external causes are to be considered which we subdivide into natural, non-natural, and preternatural. By natural causes we mean temperament, age and sex. By non-natural causes we mean six non-natural things. The preternatural causes can be various and manifold. But before we treat these, it seems appropriate to say in advance something about contagion, because this also finds its place among the external causes.

§15.

As said in paragraph 6, Elephantiasis is a contagious disease, but it is to be explained which diseases are properly called contagious. Honorable John Albertus Sebizius, my Professor and Protector, says in his *Pathological Treatises, page 265*, that those diseases are contagious which arise from contact, procreation or miasma, and send filth into another body and through this bring forth a disease similar to the species itself; in our case it brings forth the very Elephantiasis.

§16.

But what is properly meant by contagion expresses Paulus Zaach. *in quaest: med. Legal.* saying contagion is an infection passing from one individual into another, but since accidentals cannot pass from subjects to subjects, it follows that this infection cannot come from the disease but must take place through contact. According to Doctor Johannes Albertus Sebizius this contact is twofold: mediate and immediate. The Authors assert that contact becomes immediate when two bodies unite themselves, *f.i.* if one had sexual intercourse with a leprous woman, thence would come a leprous child; for more frequently through sexual intercourse can this disease befall men, and Varandaeus thinks that this reason is at the bottom, because in sexual intercourse after the spermatic vessels have been opened, it is easy that this stain is carried with the liquids to the liver, but since in the liver the sanguinification itself is frequently done, miasmas can be easily diffused into the whole body with the blood through the veins. Not seldom do children imbibe this very plague with the milk. Finally this disease is contracted through mediate contact when miasmas are present in clothes, linens, and other things of this kind.

§17.

We now go back to the natural causes which we have mentioned in thes. 14; here we shall first consider those natural causes which abundantly serve as a sign to bring about this disease. But from these presents itself. 1. *Temperament* (*constitution*) which is especially bilious not only of the whole body, but also of the principal intestines. For Varandaeus writes that those who are of a putredinous temperament very bloody or atribilious who have a drier liver with a hot and warm abdomen, or weaker spleen, less apt to purify the blood, are subject to this disease.

§18.

2. *Age.* That those arrived at the years of manhood are more subject to Elephantiasis is to be concluded from the abundance of hotter (sharper) blood; for a very great heat is aroused which consumes the humors and dries them up. But that men have sharper blood than boys is the consensus of physicians; hence, in boys no heat goes out, no humor is consumed and everything is dissolved by the sweet nectar of the humors.

§19.

3. *Sex.* This disease more often attacks men than women; for many impure things in women are discharged when they pay their lunar tribute to nature which, if remaining in the body, could indeed be the causes of many very serious diseases.

§20.

Let us now proceed to the non-natural causes which are again divided into necessarily and not necessarily changing us. Necessarily changing us are: *warm air* which warms our body in a wonderful manner and burns and dries up by virtue of its warmth everything that is in us; *cold air,* which contracts the pores of the skin not per se, but per accidens. Many things are attributed to humidity, especially in Autumn during which much putrid matter as a rule accumulates in our body.

§21.

*Food and Drink,* when one sins either in quantity or quality, or order of taking. It is said to sin in quantity of food when more is taken than can be digested by the stomach and from which much undigested food accumulates which is the cause of many diseases. For where, as Hippocrates *aphor.* 17. *sect.* 2. says, food in greater abundance is taken against nature, that therefrom sickness arises shows the very cure. Foods lacking quality when they are hard to digest, full of humors giving little nourishment, of such kind are smoked meats, ass's flesh which by its peculiar strength brings about an atrabilious humor, as the Authors assert; finally, everything that is salted. The same is the case with drink. The order of taking is not observed, when another food is taken or given, the first not yet being digested; for in this way it destroys the heat of the stomach, this being destroyed the digesting of food is injured and this being injured no valuable chyle is produced and conveyed to the liver, communicates its impurities with which it is filled to the liver itself; these impurities either remain in the liver or are removed to other parts of the body and hence, such an abyss of ills.

§22.

*Motion and Rest,* when moderately taken, eventuates into a benefit of our body, when unseasonably taken, it produces a much greater injury. Taken seasonably, they revive the spirits, cool the heat, and help digestion. Unseasonably taken they weaken the spirits, destroy the heat and elicit it; hence, the digesting of food does not attain the goal at which it aims.

§23.

*Sleep and Sleeplessness.* Since the reason for these is the same with the foregoing, we think it superfluous to repeat the former. To these we add the mental sufferings for which the same reasons hold good.

§24.

*Waste matter discharged from and retained in the body.* By what things the bowels are stopped up, in these, as a rule, impurities accumulate which, acquiring a malicious quality, can be the cause of such a disease. They cause the same to those whose period is checked or whose flow of usual hemorrhoids is arrested; for through the hemorrhoidal veins the atrabilious blood is driven out: here nature has bestowed a great benefit upon these, since it wanted them to be so happy that everything, which could bring the greatest and most pernicious annoyances upon the body, is removed.

§25.

Having absolved the non-natural causes we now come to the preternatural, which occasion Elephantiasis: When namely our body has suffered for a long time, the mange or leprosy can easily turn into Elephantiasis, as those can be prone to Elephantiasis, who have suffered from continued fevers. Sometimes also there is a hyperphysical cause when the just punishment of God inflicts this most loathsome disease upon certain individuals.

§26.

Not necessarily changing us, as poisons, bites, stings, smell from basil which, however, seem to be nearest the productions of little old women: baths, wines, clothes, etc.

§27.

After having looked into the causes we now come to the distinctions, of which various are mentioned by various Authors. The Honorable Melchior Sebizius distinguishes three degrees or species of Elephantiasis incipient, advancing, well established. The incipient has milder symptoms, however, with time advancing it acquires greater strength, when graver symptoms become visible and is called advanced, this causes the greatest trouble to physicians, but since it can hardly be overcome, it finally goes into well established which is attended by the greatest and most dangerous symptoms; heavy breathing, so that the patients are forced to breathe through the open mouth which happens on account of closed up nostrils, on account of tubercles in the throat, and are in the greatest danger of suffocating; the senses suffer, sight becomes dim on account of a small skin growing in the eye and if it covers the whole eye, sight is completely lost. The sense of feeling is so destroyed in certain parts, that the patients hardly feel the puncture of a small needle. Liddelius makes three distinctions: One less dangerous, somewhat red coming from the burnt atrabilious humor, another more dangerous coming from burnt yellow bile and the last coming from the burning of the atrabilious humor mixed with salted, thick mucus, which the kind reader may see p. 448, Varandaeus mentions another distinction and says that one is in fieri, the other in facto, in his treatise on Elephantiasis p.m. 16, but only on the distinctions. We also make mention of other distinctions. thesiz. v. 12.

§28.

After the distinctions it will be worth while to have a not less diligent than accurate knowledge of symptoms. In order that, while those suspected of this pest, are subjected to examination, the physician does not betray his ignorance and make himself a laughing stock of the bystanders; for it has been heard more than once that those who are not leprous have been pronounced leprous as well as those who were leprous have been pronounced not leprous; a fact which has caused the greatest sorrow and the cause of this is alone to be attributed to the ignorance of the physician. For, when a physician judges a non-leper a leper and a leper a non-leper he makes his conscience very much troubled; for by virtue of such a judgment a non-leper is sent into exile: he is forced to leave his wife and children with whom he has intimately lived. From this a still greater calamity ensues, for when he takes a real leper for a non-leper, from his cohabitation, miasmas are communicated to others from which communication a similar plague arises. We quote history of both errors from Platerus and refer the kind reader to his observations *lib. iii p.* 667.

§29.

From this we hope it will be clear enough how necessary and how advantageous it is to have a knowledge of the symptoms. But let us mention them appropriately. To be considered are:

1. Diagnostic symptoms which for certain reveal us the present state.
2. Prognostic symptoms which reveal us the future state.

§30.

Diagnostic signs of the disease are either beginning or well established. When the disease is in its incipiency, the healthy part of the complexion vanishes, the skin appears more discolored, there is difficulty of breathing; for many flatuses are created which, by compressing the diaphragm, occasion difficulty of breathing, there is a considerable contraction of the stomach (belly) on account of the warmth of the humor; for, as said above, everything warm dries up, besides, there is a very great tendency to venery, the breath is fetid on account of the badness of the humor, there is a feeling of numbness or coldness in the feet. However, since from these things nothing certain can be concluded, let us proceed to other signs which emphatically declare the presence of this disease.

§31.

But since leprosy propagates itself nowhere more than in the head, let us properly examine its signs; for, as Our Venerable Melchoir Sebizius writes, no one is to be pronounced leprous who has had these signs not in the head. There is a falling of the hair from the head, partly on account of the badness of the humor which eats them up, partly on account of lack of good nourishment, and if the hair is torn out, there appears a white pus, and simultaneously the skin is torn out, this, says Sennertus, is a most certain sign of lepra. Under the skin of the head, hard tubercles offer themselves to the touch and which are perceived around the forehead and cheeks, and assuredly it is wonderful since nature always pushes outward those things which are troublesome to her and what is even more wonderful because in this disease it sends matter to the face, for which we can entertain many opinions. The eyes appear round, their look fixed and immovable, the veins of the temples, as well as those which are under the tongue, and are called ranines, are blackish on account of the abundance of the humor: from these things it is manifest that the whole bloody mass is replete with and contaminated by this humor. The nose swells up and is made flat or snub, and its bones are corroded; red pustules appear under the eyebrow, the lips are thick, from the chin, hair flows down filled with poison, the color of the face is somewhat red, yet better called somewhat blue, in the mouth are seen large pimples wherewith pigs are affected and are called *Die Finne*. The gums are eaten up, the teeth are blackish, a small skin is seen in the eyes, the columella is annihilated. Other things are noticed also in other parts of the body, the fingers of the hands and the toes of the feet split open through dryness, the nails are split and torn to pieces, the whole skin, as Fernelius says, dries up and is made rough by a foul and dry scab and this sometimes with itching whence, influencing their lustful desires they feel ticklings as if worms crawled on them, and this is due, as Sennertus hands down, to the burnt up fumes and vapors ascending under the skin; besides the feeling is obtuse so that they hardly feel the puncture with a small pin; the whole flesh of the muscles is corrupted, and on hands and feet the most sordid ulcers are seen; finally, the whole structure of the body is deformed. With such great fierceness this grim enemy vents his rage upon us. And, therefore, these are the principal signs from which we can truly gather the presence of Elephantiasis. To those signs which inexperienced chirurgeons take from the urine and blood, we give no faith. For experience has taught that these uncertain signs have been entirely fallacious *cf. in Spec. Med. Pract. Doctor Sebizius. Prax. Plat. in Fernelius* and *Sennertus.*

§32.

Let us now pass over to the prognostic signs which reveal to us the future state, but as has become known from the preceding thesis that this evil is most serious and most difficult, it will hardly call for our attention, and especially an evil which seems already inveterate and has gone into an acquired perfect state. Yet, by no means, are the patients to be deserted, but must be aided by extreme remedies, for, according to Hippocrates, the most acute remedies are the best for the most acute diseases. And as Avicenna writes, even when they become monstrous in practice, and against hope, those are restored to health who have been given up. Whilst the disease is still in its diathesis, it can admit of medical attendance: although this is done with difficulty, as Sennertus writes, this may perhaps be due to the reason that this disease lies hid in the body sometimes a long time before it puts forth its strength and violence. For it betrays itself too slowly and not before the badness of the humors has besieged and corrupted the internal organs; but since it is contained in literary monuments that some have been restored to their former health, we shall briefly annex the cure.

### §33.

In order that we rightly set up this cure we think that it is to be taken from a threefold source. Chirurgic, Pharmaceutical, Dietetic. For from these we must fetch also suitable remedies.

### §34.

From the chirurgic source we recommend:

1. The cutting of the veins, although Authors may be found who warn the patient against this, but we do not see why it should not be done. For Galenus boasts of having cured many by cutting and the cleansing of the vein; but which vein is to be opened is to be inquired into. The Arabians are of the opinion that the salvatellas should be opened, because nature is in the habit of going from the nobler to the ignobler parts which she causes to thrust down, which opinion we also embrace.

2. Application of gourds [*cucurbitulae*] and scarification to the various parts, for thereby bad matter is attracted and discharged.

3. Puncturing. 4. Cautery. Varandaeus prescribes that both should be applied to the legs.

5. Castration because by this the temperament is changed, and Valescus of Taranta says that since leprosy is too great a dryness, by the removal of the testicles the body is moistened and, as it were, effeminated. Although others think that the testicles of a leper should be removed in order that, though being very deceitful on account of the sharpness and saltness of the atrabilious humor, from the coition in which they too frequently indulge, they do not infect others and so increase and multiply the evil: Yet, since there is still some hope left to recover health, hardly anyone will recommend this remedy.

The pharmaceutical source prescribes: 1. Purging. 2. Sudorifics. 3. Specifics. 4. Alteratives. Therefore, first of all, the chyle ducts should be emptied out through lubricants such as *Manna, Cass. Diasena. Dissol. Syrup. Rosar. solut. succ. Violar. Syrup. Flor. Persic.* Having done this we proceed to the preparatives, such as *Aqu. Cichor. Bugloss. Fumar. Endiv. Borrag. Syrup. Acetosit. Citr de Fumar. Borrag. Bugloss. Granat. acidor. spir. Vitrioli, Corn. Cerv.* Emollient *Clysters*, which can be prepared from emollients adding filtrations *Benedict. Laxat. Cassia. recent Extract. Etc.* To the preparatives are joined the purgatives which are various, simple and composite. Of the simple ones we recommend *Polypod. Epithym. Diasebest. Lap. Arm. Fol. Sen. Lap. Lazul. Hellebor. nig.* of the composite ones are in use *Syrup. de Epithym. Extract. Lapid. Lazul.*; *Hellebor nigr. Senae. Diasena Nicolai, Confect. Hamech. El. Ind. Etc.* But purgings are arranged alternately some continued several days, others by turns and once four at a time, using twice in proportion as the body seems to abound in excrements. *Platerus in Prax. pag.* 438.

The sudorifics do their share to conquer this enemy. To these belong the following: *Ferr. Sigill. Lem. Lapis, Bezoar. Orient. Unicorn, Aqu. Bezoard. Elix. propriet. spirit. Guajac. Sassaffr. Syrup. e Succ. Card. Bened. Theriac.* Druggists highly prize *Antimon. Diaphoret. Croll. Spir. Tart. Croll. Tart. Vitriol. Croll. Sulph. aurat. Diaphoret. Begunii* doses from ℈*B* to ℈*j*. *Sal. Absinth. Corn. Cerv. Card. Bened.*

### §37.

We shall now consider the Specifics about which some make much ado. Bombastus Paracelsus (absurdly called Theophrastus) extols his potable gold and boasts of having cured twelve in one year (if this is credible). He thinks highly of the *liquores Margaritar* or *Extract. Antomon;* but occasionally he boasted of many secrets which had no effect. That ancient physician Oribasius very much praises the eating of vipers, for he writes that this gives a wonderful help and relief to lepers, not however, that this kind of remedy should indiscriminately and immediately in its inception be given to all, but only in advanced cases. For first the universal cure [remedy] should be undertaken through purgations and cutting of the veins, so advises Eustath. *p.m.* 166. For the preparation of vipers see the same Author, also Varandus *p.* 50. Sylv. Ambianus recommends dry meat of the wild hedgehog. It is handed down by tradition that human blood drunk from one whose throat has been cut has been of benefit.

§38.

But since drugs very much prostrate strength therefore we rightly add those that strengthen much. They are the following: *Aqu. Meliss. Borrag. Bugloss. de Rubo idaeo. Margarit. Corall. rub. Unicorn. Syrup. Caryophyll. hortens. Florum Aurant. Magist. perlar. Corall.* can be applied to the nostrils, *Aqu. Rosar. Cinamon.*

§39.

Last, the dietetical source. Air inclining more to cold than to heat should be chosen. Food should be εὔπεπισι [easy of digestion] εἴχυμοι [well flavored] and πολσιρόζοι [nutritious]. Drink, if the patient was used to wine, the wine should be diluted. Sleep and nightly vigils should be moderate; sleep, however, can be longer because it does not moisten the body at all. The same is the case with exercise and rest. More serious mental sufferings should be avoided. Excreta and retenta should be done according to the laws of nature. Care should be taken that no suppression of the usual evacuations takes place. These things having been observed there will be no doubt that the patient is restored to his former health. But here I stop rendering eternal thanks to God, because He, not only in the whole curriculum of my studies, but also whilst I was writing this debate, has assisted me with His grace, but also, because He brings about that everything tends to the glory of His Divine Name and to the welfare of our neighbor.

### Eulogy.

Nothing increases to Thee, Niesius, the honors of a Doctor, nothing gladdens Thee with the Honor of the Prince of the Gens Ascelpia [or Prince of the Asclepediae] but that which a free mind, inherent to thy studies, worthy of a Hercules, has spoken of Elephantiasis. Of Thy virtues [talents], O Niesius, in which the Muses have delighted, the other signs the Chair will now give us; and showing from the Aonian Chorus thy strength in the contest this splendid Elephantiasis depending upon God. But soon thou wilt reach the highest summit of Pindos, and I gladly see Thee in the Aonian mountains. The inaccessible height of things does not lead away the minds: The Higher the summit, the superior thy mind. Thou already settest the rewards of the work begun and the wages of thy labor. For there is a crown of laurel worthy of thy high merits. And a little while ago thou hast meditated upon the Pierian Laurels and from these thou shalt soon see the conspicuous crown. But depending upon God and the crown of laurel, Niesius, may go such distinguished titles of Medical Doctor. Farewell.

The Candidate, Patron and Dearest Friend,
So Congratulates Heartily,
William Nisetus
Aquisgr. L.L. Stud.

# STUDIES IN PALEOPATHOLOGY XXI

## INJURIES TO THE HEAD AMONG THE PRE-COLUMBIAN PERUVIANS

BY ROY L. MOODIE, PH.D.

CHICAGO

THREE studies have been planned to show the development of the surgical idea among the isolated, primitive and ancient inhabitants of Peru during the Incaic period. The chronology of this time is of so uncertain a nature that we must leave this out of account, and deal only with the evidences as we see them. The first paper of the series is the present one dealing with injuries to the head which undoubtedly were the direct cause of many of the operations of trephining which are by far the most abundant evidences of surgical procedure. A second paper will deal with luxations, and fractures of limb bones, while a third will give the evidences of trephining, amputations, bandaging, excisions, cauterization, and all other practices which may justly come under the general heading of Surgery. We shall be especially interested in showing the definite relations existing between fractures of the skull bones and trephining, as well as the same relations between diseased areas and surgical interference.

The ancient Peruvians were the most isolated of all prehistoric peoples and they developed a civilization which has aroused the interest of all the world. Their ideas were not received from others but were original with them. Their surgery was but a part of their general culture.

### Historical

The subject of head injuries has attracted the attention of scientific men from remote antiquity. We are assured of Neolithic man's devotion to this subject by the number of trephined skulls which have been discovered in Neolithic deposits. Human relics are the only records of primitive man's attention to this difficult field of surgery and we have no other means of knowing their attempts at recording their methods of thought. The proper interpretation of their skill and knowledge depends upon our understanding of the purposes the primitive surgeon had in mind, whether it was done as a relief measure, as a religious procedure or as the result of some little-understood process of thought among those ancient and uncultured peoples who performed this operation on the head.

The first *written* account of man's interest in head injuries is found, according to Charles Singer,[1] in the Hippocratic Collection under the title "Wounds of the Head." This was supposed to have been written by a practical surgeon about 400 B.C. The operation of trephining is admirably described, and there is presented, in the Hippocratic work, a knowledge of technique and a scientific interest that is vastly in advance of the powers of Neolithic man.

There have been a great number of contributions to medical literature dealing with head injuries since the Hippocratic collection, but it would serve no useful purpose to list those papers here. It will suffice to mention Cushing's[2] contribution to the general subject and dealing particularly with injuries received during the World War.

It is only among the remains of the ancient Egyptians that there has been any organized attempt to record head injuries for the purpose of determining ancient man's interest and skill in surgery. It will only be necessary here to mention the work of G. Elliot Smith and F. Wood Jones whose studies have been listed in my volume "Paleopathology" and need not be given again.

I believe it to be correct to state that no primitive and ancient race of people anywhere in the world had developed such a field of surgical knowledge as had the pre-Columbian Peruvians. Their surgical attempts are truly amazing, and include amputations, excisions, trephining, bandaging, bone transplants(?), cauterizations, and other less evident procedures. It is the purpose of this and the following papers to determine and describe the reason for their surgical advances, their operations and all accessory factors, to determine the manner of reasoning among this wonderful, ancient race.

Fig. 1. A Pre-Columbian Grave in a Cemetery at Chilca, Peru, Which Has Been Rifled of Its Contents by Treasure Hunters, and the Skeletal Remains Thrown Carelessly about the Edges of the Excavation. It Was from Such Localities as This That Dr. Ales Hrdlicka in 1913–14 Made the Collections of Pre-Columbian Peruvian Material Now Stored in the San Diego Museum at Balboa Park and in the United States National Museum. Such Material Is Difficult to Associate with Its Proper Skeletal Elements. It Forms the Basis of This and Other Papers. (After Hrdlicka.)

## Materials

This study is based almost entirely on the collection of Peruvian material at the San Diego Museum of Anthropology at Balboa Park, which has already been fully discussed in a previous paper of this series.[3] This collection contains 119 skulls which show lesions due to injuries, as well as a very great many skulls showing trephining, and a few showing the relation of trephining to injuries. An examination of these specimens will go to show that trephining of the head was frequently employed for the relief of depressed fractures, for the relief of (supposedly) frontal headaches, and other interesting matters. I do not intend to assert that I have discovered that trephining was employed for the relief of fractures, for this has been the accepted opinion of many anthropologists for some time. I have only shown here by figures and descriptions how surgery was brought to the relief of injuries and especially to show by figures of the skulls the nature of the lesions, and from their condition the probable cause of the injury, and the surgical attempts to correct the defect. A brief discussion, with figures, gives some account of the weapons used by the pre-Columbian Peruvians, since only by understanding these can we properly appreciate the nature of the head injuries.

Other collections have been seen in this connection, and notes made of some of the more obvious conditions. The huge collection of Peruvian material at the United States National Museum has been examined briefly. Its relation to the collection in San Diego is discussed in my Studies No. XVIII.[3] Many important objects were examined at the American Museum of Natural History. The collection in the Peabody Museum at Harvard University has been seen. The large collection at Yale University studied by G. G. MacCurdy was briefly examined for head defects. Its relations to the present subject is given in a previous paper. Other smaller assemblages of materials of this nature have been considered, but the descriptive matter is confined to the collection at San Diego, since this is the only collection made from Peru for the express

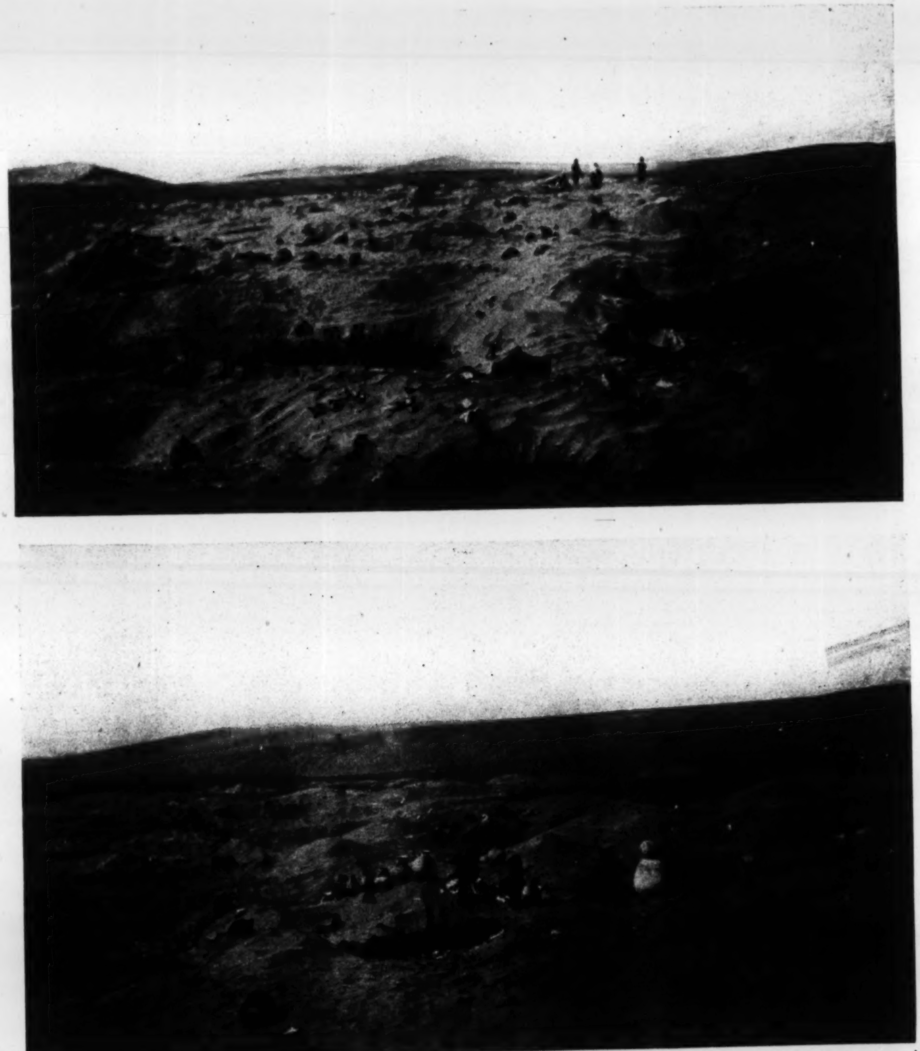


FIG. 2. PERUVIAN CEMETERY, IN ALL PROBABILITY PRE-COLUMBIAN, AT KILOMETER 98, ON THE RAILROAD FROM ANCON TO HUACHO, DESPOILED BY PEONS. THE CONDITIONS SEEN ARE QUITE TYPICAL OF MANY SIMILAR SITES IN PERU IN 1913. THE GOVERNMENT HAS SINCE THAT TIME PLACED INJUNCTIONS AGAINST SUCH VANDALISM.

UPPER—WASTE OF POTTERY, SKULLS AND BONES. A PARTY OF PEONS EXCAVATING FURTHER ON.

LOWER—ANOTHER PART OF THE CEMETERY. THE POTTERY IS THAT OF LESS SALABLE GRADES AND THEREFORE BROKEN OR ABANDONED BY THE DIGGERS. (AFTER HRDLICKA.)

purpose of illustrating the Paleopathology of that country. It is kept clearly in mind, however, that there are other collections, at home and abroad, which might furnish other additional examples of injuries. The description of new types of injury, while interesting, would not add materially to the purpose of this paper which is to discuss the causes of the development of surgery in pre-Columbian Peru.

The collections of pre-Columbian Peruvians and prehistoric Egyptians at the Field Museum of Natural History have been studied from a large series of roentgenograms of the greatest excellence. The results of this study will be given elsewhere and are mentioned here simply to show that the discussions given in these three papers are based on a fairly large amount of material.

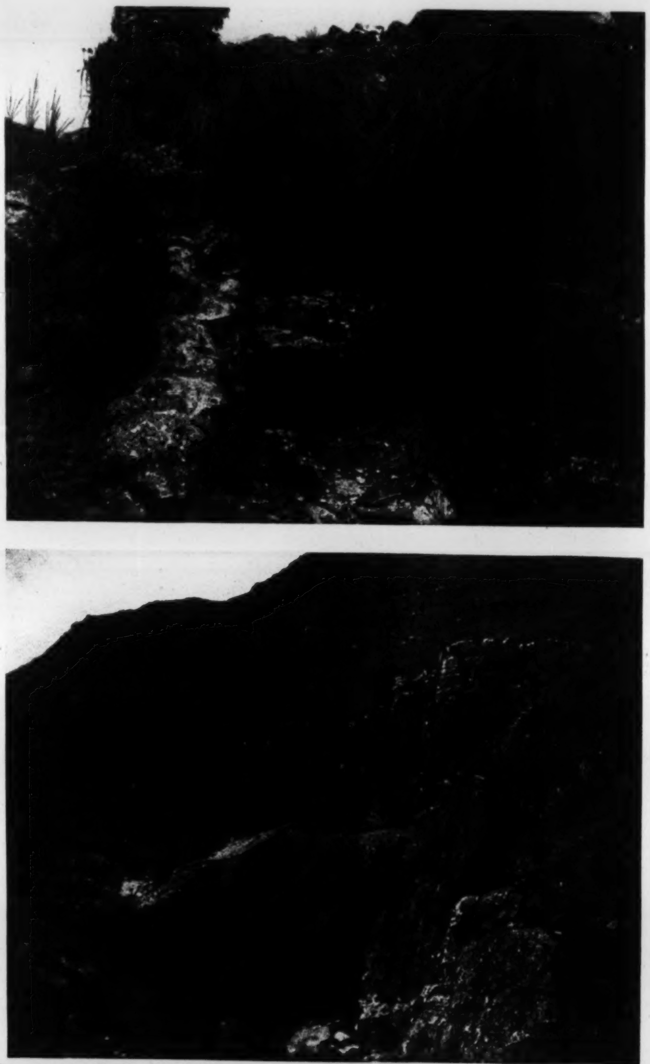


Fig. 3. Since the Digging of Graves Was Difficult or Impossible in the Rocky Highlands Recourse Was Made to Caves, Large or Small, to Holes, Rock Shelters or Other Natural Places for the Disposition of the Dead. MacCurdy and Eaton, Whose Writings Are Listed Elsewhere, Have Discussed the Methods of Interment in the High Mountains.

Upper—Small Burial Cavern, Amidst Ruins Covering a Large Part of the Top of a Mountain Just Northwest of Huarochiri, Peru, from Which Some of the Material Discussed Herewith, Was Obtained.

Lower—Burial Hole; Ruins above. Same Locality. (After Hrdlicka.)

### NATURE OF THE INJURIES

The lesions exhibited by the 119 pre-Columbian Peruvian skulls are often of such shape that the cause of the injury can be determined, i.e., whether by a blow from a club, star-shaped mace, sling shot, arrow-point or other weapon. Some of the fractures may have been produced by a fall, but nearly all are of such a nature as to indicate the possibility of their being war injuries.

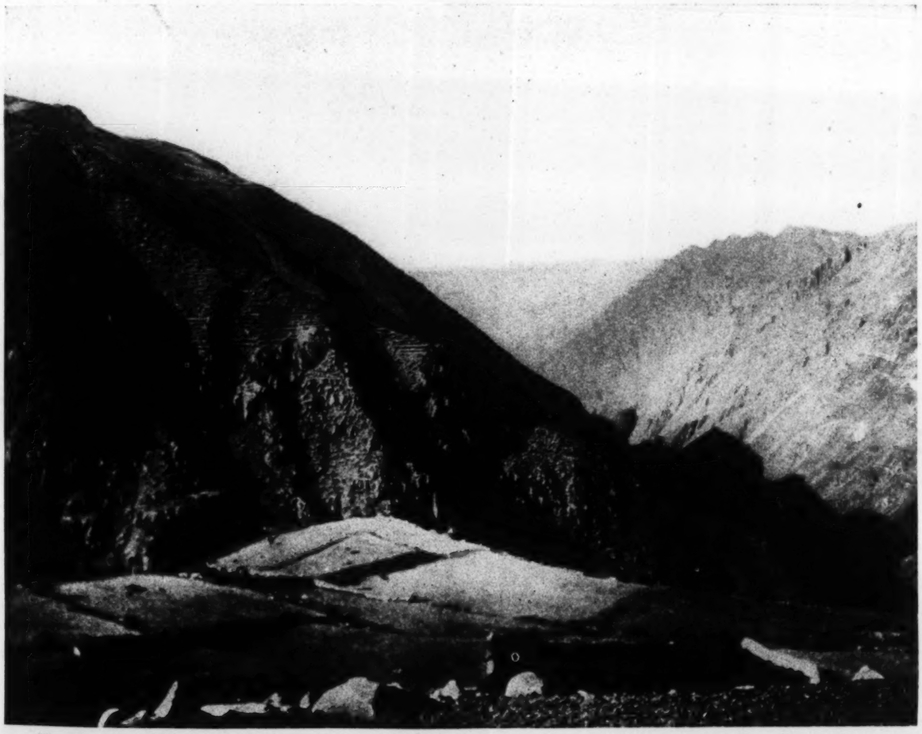


FIG. 4. THE LOCALITY, NEAR SAN DAMIAN, PERU, KNOWN AS CINCO CERROS (MEANING THE FIVE PEAKS ACCENTUATED IN THE BACKGROUND) WHERE MANY OF THE INJURED AND TREPHINED SKULLS, NOW PRESERVED IN THE SAN DIEGO MUSEUM, WERE COLLECTED. AN ANCIENT AND PERMANENT FORT IS THOUGHT TO HAVE BEEN LOCATED HERE.. (AFTER HRDLICKA.)

Some of the wounds may have been due to blows following disputes of possession, though the policy of the Incas would make this seem improbable. It is well known that the rulers of ancient Peru were overlords and possessed their entire country and would not tolerate private disputes, but their discipline in remote mountainous regions was probably not very strict. Skull No. 1 with its array of numerous sling-shot injuries may have belonged to the village fool, a scapegrace for the rest of the people. It is thus quite probable that some of the injuries recorded here were not due to war, and many of the individuals whose skulls are contained in the collection were not soldiers.

The injured skulls are derived from the following localities, the position of which may be determined by reference to the map in Figure 15 of the Studies in Paleopathology, XVIII.[3] The 119 skulls were secured by Ales Hrdlicka at Nasca 20, Chavina 13, San Damian 19, Cinco Cerros (a prehistoric fort near San Damian marked by the five peaks shown in Figure 4) 14, Huacho 9, Lomas 14, Huarochiri 4, Chilca 3, Pachacamac. 5, Matacana 3, Chicama 4, Coyunga 3, Ancon 3, Conventillo 2, Quintai 2, Ica 1. The sex of the 119 skulls is: 51 males, 40 females, 3 youths and 25 of uncertain sex because of the fragmentary nature of the material. If the injuries are due to war then we must conclude that women took an active part in battle since the proportions of male and female are so nearly equal.

The 119 skulls discussed herewith bear the following numbers in the catalogue of the San Diego Museum at Balboa Park: Nos. 1–42, 45–46, 47–50, 52–53, 55–56, 61–64, 69–77, 80, 82–87, 89, 91–94, 96–99, 124–126, 130–131, 134, 235–236, 245, 247–250, 254, 266, 283–284, 291, 299, 301, 322–323, 651–654, 656, 657–658, 660–662, 664–666. (The numbers, 651–655, represent the accessory objects described, Figures 5 and 6.)

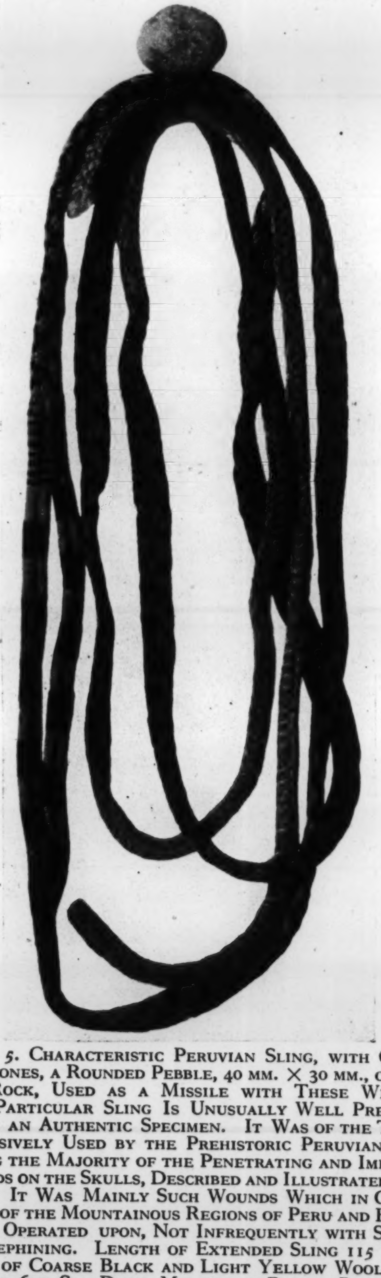


Fig. 5. Characteristic Peruvian Sling, with One of the Stones, a Rounded Pebble, 40 mm. × 30 mm., of Igneous Rock, Used as a Missile with These Weapons. This Particular Sling Is Unusually Well Preserved and Is an Authentic Specimen. It Was of the Type so Extensively Used by the Prehistoric Peruvians, Producing the Majority of the Penetrating and Impressed Wounds on the Skulls, Described and Illustrated Herewith. It Was Mainly Such Wounds Which in Certain Parts of the Mountainous Regions of Peru and Bolivia, Were Operated upon, Not Infrequently with Success, by Trephining. Length of Extended Sling 115 Inches, Made of Coarse Black and Light Yellow Wool. Nos. 652 and 653. San Diego Museum at Balboa Park. Collected by Ales Hrdlicka.

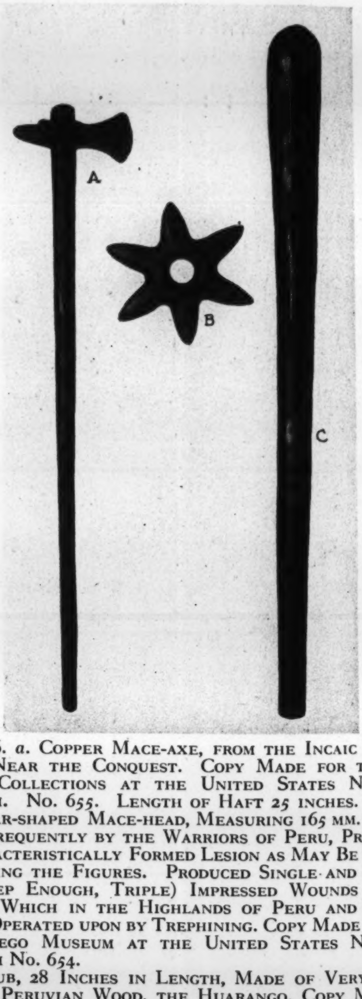


Fig. 6. *a.* Copper Mace-axe, from the Incaic Period, Peru, Near the Conquest. Copy Made for the San Diego Collections at the United States National Museum. No. 655. Length of Haft 25 inches.

*b.* Star-shaped Mace-head, Measuring 165 mm. Across, Used Frequently by the Warriors of Peru, Producing a Characteristically Formed Lesion as May Be Seen by Examining the Figures. Produced Single and Double (if Deep Enough, Triple) Impressed Wounds of the Skull, Which in the Highlands of Peru and Bolivia Were Operated upon by Trephining. Copy Made for the San Diego Museum at the United States National Museum No. 654.

*c.* Club, 28 Inches in Length, Made of Very Heavy Native Peruvian Wood, the Huarango. Copy Made at the United States National Museum. These War Clubs Were of Various Shapes and as a Rule Rather Crudely Made. They Were in Much More Common Use among Some of the Peruvian Native Tribes Than among Others, and Produced Some of the Frightful Wounds Shown on the Skulls Depicted Here, as Well as on Other Parts of the Body. No. 651 San Diego Museum.

### Weapons of War and of the Chase

The sling (Fig. 5) was the most characteristic weapon of the pre-Columbian Peruvians. The missiles, usually rounded pebbles of volcanic rock, were carried in a pouch at the waist. Long practice enabled the people to throw for incredible distances with a force and accuracy that was truly amazing. Its use was common in the northernmost parts of South America, as well as in Mexico and Central America. The sling was expecially important in certain coastal regions of Peru in pre-Inca times, and it is also one of the chief weapons of the people in the mountains. By the Incas the sling was given a still wider distribution. Means[4] has written of the details of the pre-Columbian slings collected by Hrdlicka in his expeditions to Peru for skeletal material. Nearly all of the slings were woven of wool. The prevalence of this material indicates a well-developed trade between the coast and the mountain regions, for the wool-bearing animals indigenous to Peru all live at high altitudes. The color and design of the slings are admirable, the usual colors being black, white, brown, yellow and red. The designs are usually geometrical.

The efficacy of the sling shot as a weapon is evidenced by the prevalence of depressed fractures due to the impact of the missile on the cranium, often entirely penetrating the skull and producing a mortal injury. A study of the figures will show the frequency of the injury producing a characteristic and unmistakable lesion. At times fracture lines develop from the place of impact of the sling shot, as shown in Figure 9. The lesions produced by the sling are of the very greatest interest in connection with a study of the development of the primitive surgery of Peru. The depressed fracture would produce pressure symptoms, either by the pressure of the bone itself or by subjacent hemorrhage from the meningeal blood vessels. The patient sought relief by submitting himself to an operation for the relief of pain by trephining. Trephining of course would destroy all evidence of the impact and we are left to the assumption that the injured area of bone was removed at the operation. I shall produce evidence in the next paper of this series (Studies in Paleopathology XXII, Surgery in pre-Columbian Peru) to show that the prehistoric surgeon operated intelligently in the removal of the depressed bone, and actually performed operations on the dead to improve his technique.

We are not so fortunate as Dr. Cushing[2] in being able to study the trephined plaques in their relation to the operation of trephining and its probable effect on the subjacent nervous tissues. I do not know that a single plaque due to trephining has ever been found in the pre-Columbian burials of Peru, although it has been suggested that the rondelles of bone used for necklaces by the Neolithic people of western Europe originated from trephined skulls. Such objects may have been preserved in Peru but are not mentioned in such thoroughgoing studies as that of Reiss and Stübel.[5] Dr. Hrdlicka writes me that he has never seen such an object. The lesions of the head point out that next in frequency to the sling, wounds were produced by the star-shaped mace (Fig. 6*a* and *b*). Such an injury is depicted in Figures 15*a* and 12*a*. The lesions are often huge and the point of impact of at least three of the rays of the mace may be determined. The injury due to a well-directed blow would most often prove fatal. It is possible that some of the huge trephined openings in many of the pre-Columbian skulls were effected in an attempt to relieve such decompressions.

The club (Fig. 6*c*) was often employed as a weapon. Probably it was not always carefully shaped, but any good sturdy stick of heavy tough wood would serve the purpose. Skull No. 5 (Fig. 11) shows the effects of a smashing blow on the nose from a club (Fig. 10*c*); of a star-shaped mace on the left side (Fig. 11*c*); of sling-shot injuries on the occiput (Fig. 11*b*) and many fractures resulting from these manifold injuries. The nose injury was healed.

A narrow-bladed copper axe, shown in Figure 6*a*, combined with a star-shaped mace, was employed as a weapon and was probably responsible for such injuries as that shown in Figure 16*d*. It was also used independently of the mace but because of its small size was not frequently employed as a weapon.

The bow and arrow was apparently employed very little by the pre-Columbian Indians of Peru, if we may judge from the nature of the injuries. Reiss and Stübel[5] give brief discussions of bows and arrows found in the graves at Ancon, and they are briefly mentioned or discussed by other writers but these weapons seem not to have attained much perfection in Peru. A few small circular lesions, such as those shown in Figure 15*d*, may have been produced by a cylindrical arrow point, and as such might be a cause for surgical interference. (See Nos. 245 and 247.)

Other incidental weapons are indicated. The skull lesion in Figure 10*b*, may have been produced by a large round stone hurled by hand. Cutting instruments, such as a sword, are not definitely indicated, but one or two small lesions (Fig. 12*d* and Fig. 15*b*) may have been produced by some sharp weapon. Spears would be of little use as producers of skull injuries, but if used doubtless caused injuries to the soft parts of the chest and abdomen. The heavy fracture line shown in Fig. 12*e* may have been produced by a fall, striking the head forcibly upon a rock. This and other obscure lesions may be classified under the heading of *accidents*.

### THE HEALING OF WOUNDS

The most startling thing about the many huge injuries due to trephining and the injuries received in battle is the infrequent evidence of infection. A careful count of the injured and healed skulls would show a preponderance of injuries which had healed without infection, even when the skin of the area must have been pierced. Many examples of violent infection are seen, however, as is especially well shown in the female skull, described some years ago,[6] which showed evidences of a violent infection of the vertex following a cauterization.

The length of time which elapses between the impact which caused the wound and complete healing necessarily depends on many factors and can only be judged accurately from experience. Keith,[7] however, has shown how surprisingly rapid bone repair is, on the whole, and we are enabled to approximate the time of healing. To make definite statements of the number of days which elapsed from the time of injury until death by the evidences of bone repair would require considerable surgical experience and some study. On the present dry material, of which there are no clinical records, we can only approximate the time of healing.

It is not probable that the pre-Columbian operator had much idea of asepsis and cleanliness. We may judge of this more clearly, perhaps, from the probable analogy with the Algerian practices in the Aures massif, in northern Africa, so lucidly described by Hilton-Simpson.[8]

### INJURIES TO MENINGES AND BRAIN

It is probable that the ancient Peruvians shared with other primitive and ignorant people the fear of injuring the dura mater. Hilton-Simpson[8] records the attitude of the Algerians in this matter. Possibly care was taken in trephining and cauterization to avoid doing injury to either meninges or brain. That these structures were injured, however, we can be certain from the nature of many of the wounds which are described in this paper. No mummified brains or meninges have been described from ancient Peru such as are well known from Egypt. We must conjecture from the nature of the skull lesion what the probable endocranial effects were.

Fractures of the skull bones which cut across important meningeal blood vessels undoubtedly produced severe hemorrhage, as is indicated by blood stains on some of the skulls. This may have caused considerable trouble from pressure on the cerebrum. It may have been an inciting cause for trepanation. Penetrating wounds, as from sling shots, often carried fragments of bone completely within the brain, producing a necrotic track similar to those shown by Cushing.[2] Large depressed wounds of the skull undoubtedly injured the endocranial structures. Infections of large skull injuries, whether wounds or trephined areas, undoubtedly produced changes within the meninges, even though the dura may not have been otherwise disturbed. The infection caused adhesions to the inner skull table around the wound, as is shown by the roughening of the inner skull table. Where the opening is large, or the skull broken, adequate examination of the endocranial surface may be made, and the degree of infection determined. If the opening is small and the skull complete some examination may be made with a small pocket flashlight through the foramen magnum.

There are no indications of operations on the brain itself, nor on the meninges. Many of the injuries to the endocranial structures were fatal, as we may observe from the nature of the wounds. The resistance of these people was, however, simply amazing, some of them having survived five successive trephinings, and a dozen or more skull injuries, which in others might have been fatal.

### CARE OF THE WOUNDED

We are assured from the number of the skulls of females which show injuries, often of a violent nature, that the ancient Peruvians were not at all chivalrous nor kind to women. We can conjecture from this that their care of the wounded was often heartless and inefficient. Certain indications, however, point to some attention being paid to the injured, but whether this was due to the rank and importance of the injured individual we are unable to ascertain. Probably the injured were placed in a more or less protected place and attended after a fashion, but they had to rely largely upon their own powers of recuperation. The use of bandages has already been discussed in a previous paper of this series[1] but this single instance is all we know among the many thousands of mummies and skulls which have been collected from the caves and cemeteries of Peru, so the practice cannot have been prevalent. No bed sores on any of the mummies have been seen, such as have been described among the ancient Egyptians. None of the Peruvian pathological conditions are so chronic and so far progressed as to indicate total helplessness, such as we find in the *poker spines* of Egypt.

The use of a separate house or room for the injured is uncertain. The plan may have prevailed if there were a large series of injured at one time, as after a severe battle. Where there were numbers of female attendants on the services of the Sun, as at ancient Machu Picchu and Cuzco, there may have been such attempts within the cloisters set aside for the use of those attending to matters of worship. The *hospital idea* probably had never occurred to these people. Even among the Algerians, Hilton-Simpson[8] found only one small, ill-lighted, dirty mud house set aside for the use of the injured. Only by the widest stretch of the imagination could such a place be called a hospital, as we understand the term. The injured survived through sheer immunity of their own developing. Certain plant products were used as an aid to healing which experience or superstition had shown were useful, but there seems to have been no definite materia medica comparable even to that used by the Algerians.[8]

The wounded probably did not suffer severe pain because they were doubtless chronic users of the Coca leaves, which mixed with ashes they chew constantly, with the effects of the cocaine tending to deaden the pain. We are assured of the prevalence of the use of this leaf in ancient times by its modern development, and by historical records. Leaves of this plant, tied in bunches, form one of the staple products sold in the open markets of the highlands of Peru and Bolivia today. The scorn of acknowledging pain or distress was probably as keen among these stoical Indians, as among those of the north.

---

[1] Studies in Paleopathology XIV.

### Description of Fractures, Perforations and Other Lesions

It will be worth while, in this section, to give a detailed account of the lesions in the pre-Columbian skulls. This will be done by publishing Hrdlicka's catalogue description of the specimens followed by my notes made in the museum with the object directly at hand. References to the illustrations will also be given.

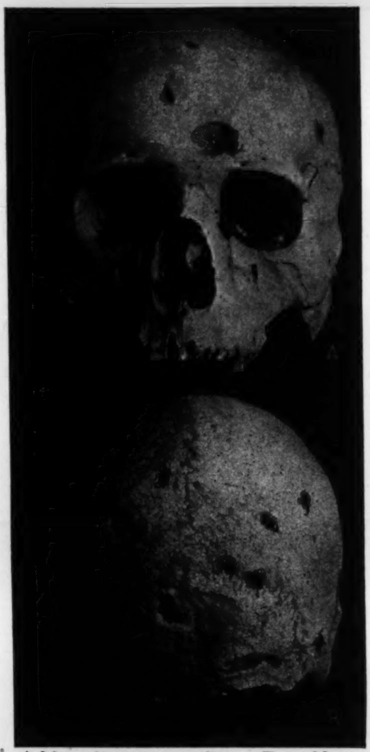


Fig. 7. A Male Prehistoric Skull From Nasca Region, Peru. The Thickheaded Village Fool. No. 1 of the San Diego Museum, Showing the Location and Extent of Several Small Depressed Areas, More Than a Dozen of Which Are Due to Sling-shot Injuries at Different Times. All Fractures Are Confined to the Outer Skull Table and the Diploic Space. The Largest Area of Depression Is on the Forehead, Depressed into the Frontal Sinus. This Skull Is Shown in Figure 8, *a* and *b*. A Comparison of the Figures in 7 and 8 Shows How Shallow the Depressed Wounds Are, Possibly Intended Merely to Annoy and Not to Kill.

*a*. Face with Large Depressed Area Over Left Frontal Sinus.

*b*. Occiput Showing Ten or More Depressions. The Outer Skull Table Is Checked by Weathering so It Is Impossible to Tell How Many Scars There are. I Have Counted Indications of About 20, but Some of These May Not Be Sling-shot Wounds.

No. 1. Prehistoric skull from Nasca Region, Peru. Male. Old wound in forehead. A number of dents over vault.

The skull is bleached white and the outer table rendered scaly by exposure to the weather. This makes the proper interpretation of all the lesions on the vault uncertain. Many of them are certainly sling-shot wounds. I count ten dents which are more or less obvious injuries, three of them partaking of the nature of depressed fractures. One of these is on the left side immediately adjacent to the coronal suture, just above the temporal ridge. The largest is just over the left frontal sinus, and is depressed over an area of some size. There is a minute opening at the bottom of the depression which doubtless led into the sinus cavity. None of the injuries were infected, and none were serious. All of the injuries are well healed, and all are probably due to sling-shot injuries. (Fig. 7, *a* and *b*; Fig. 8, *a* and *b*.)

No. 2. Prehistoric (or early historic) skull from Chavina, Acari Valley, Peru. Male. Old club or stone wound over the frontal, with fracture running down to sphenoid. Healed.

The injury shows in the smooth edges partial healing. The point of direct impact lies immediately above the superior temporal line. The depressed area on the frontal bone is about 35 mm. in diameter, produced by a large sling-shot pebble. A fracture line, somewhat curved, runs anteriorly from the coronal suture for a distance of 30 mm. It then passes another concentric fracture which arose from the point of impact. The palate is almost edentulous, and a large perforation in the palate indicates an infection in the maxillary sinus. (Figs. 8, *c* and *d*; 9*a*.)

No. 3. Prehistoric skull from San Damian. Male. Old healed lesions of the nose, malar, temporal and occipital bones, all on the left.

This skull shows the healed effects of a severe injury, possibly due to a smashing blow from a club, across the left eye. The root of the nose is badly crushed, and the left orbital margin is fragmented. (Figs. 9*b*; 10*a*.)

No. 4. Prehistoric skull from Huacho, Peru. Probably male. Extensive impressed wounds on the right side with radiating fractures, all healed.

A lesion probably due to a large rounded

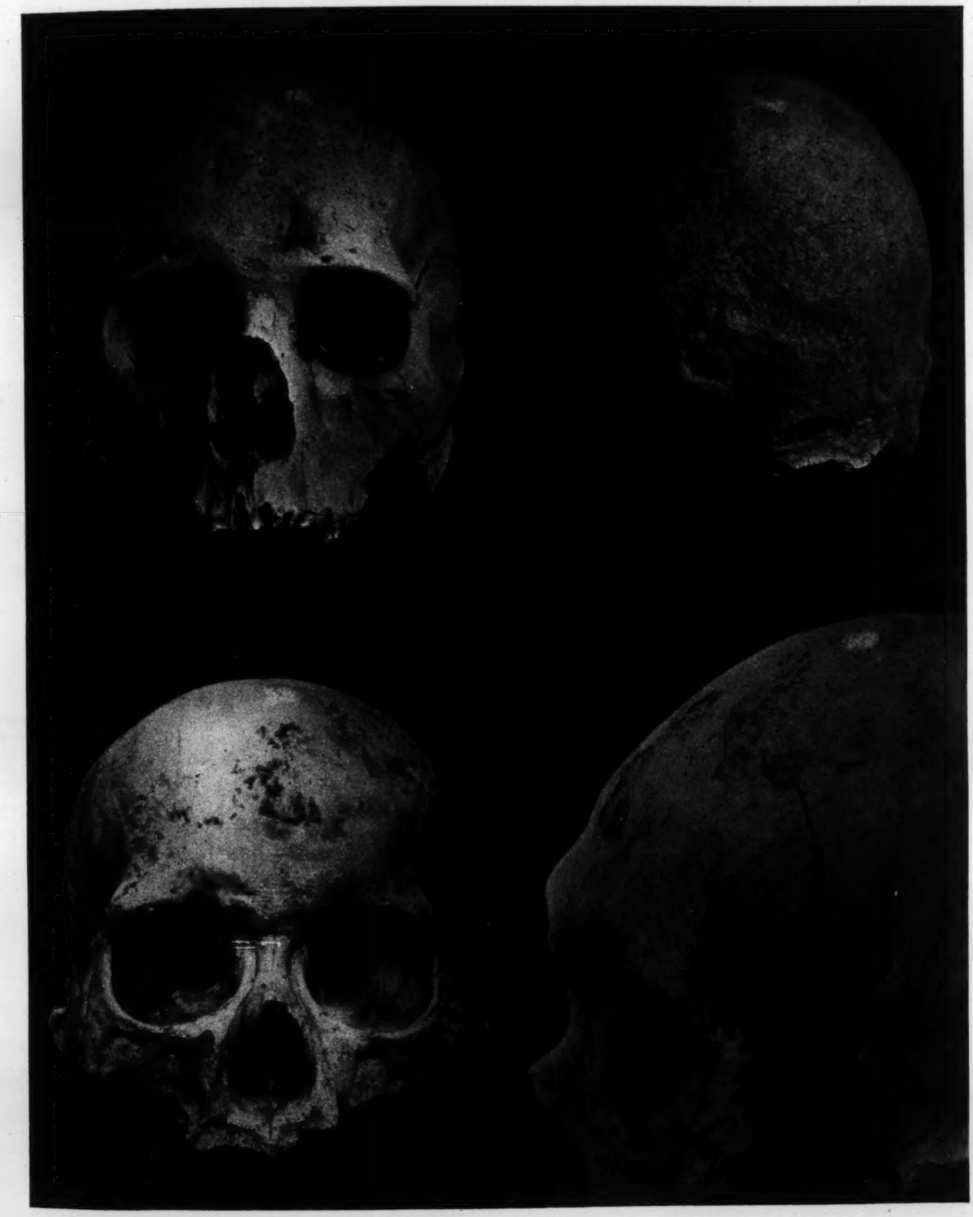


Fig. 8. Prehistoric Skulls from Peru Showing Injuries.

*a* and *b*. The Numerous Sling-shut Injuries Are Barely Visible in These Untouched Photographs. The Locations of the Lesions Are Indicated in Figure 7. The Depressions Are Very Shallow. It Is Interesting to Speculate on the Social Status and Mental Condition of This Individual Whose Head Served as a Target for So Many (Juvenile?) Sling Shots.

*c*. Face of a Prehistoric Male Peruvian. Edentulous, but Still Vigorous, Able to Survive for Some Time a Severe Concussion from a Large Sling-shot Stone (30 mm. in Diameter), Which Struck the Left Frontal So as to Produce a Long Fracture Line Extending to and Involving the Sphenoid (Fig. 9*a*). The Injury Shows Some Healing but It is a Mystery How the Individual Escaped Death from Hemorrhage of the Middle Meningeal Artery. No. 2, San Diego Museum.

*d*. The Left Temporal Region of Skull No. 2, Showing Location and Extent of Injury. No Evidence of Surgical Interference.

stone hurled by hand. A fracture line runs circularly around the entire depressed area, with several radiating fractures. There are no evidences of infection. The coronal suture is shown on the right (Fig. 9*c*). The junction of this suture with the temporal is involved in the injury (Fig. 10, *b* and *d*).

No. 5. Prehistoric skull from Cinco Cerros, Peru (near San Damian). Male. Multiple mace injuries on sides and back. Also an old scar on occipital.

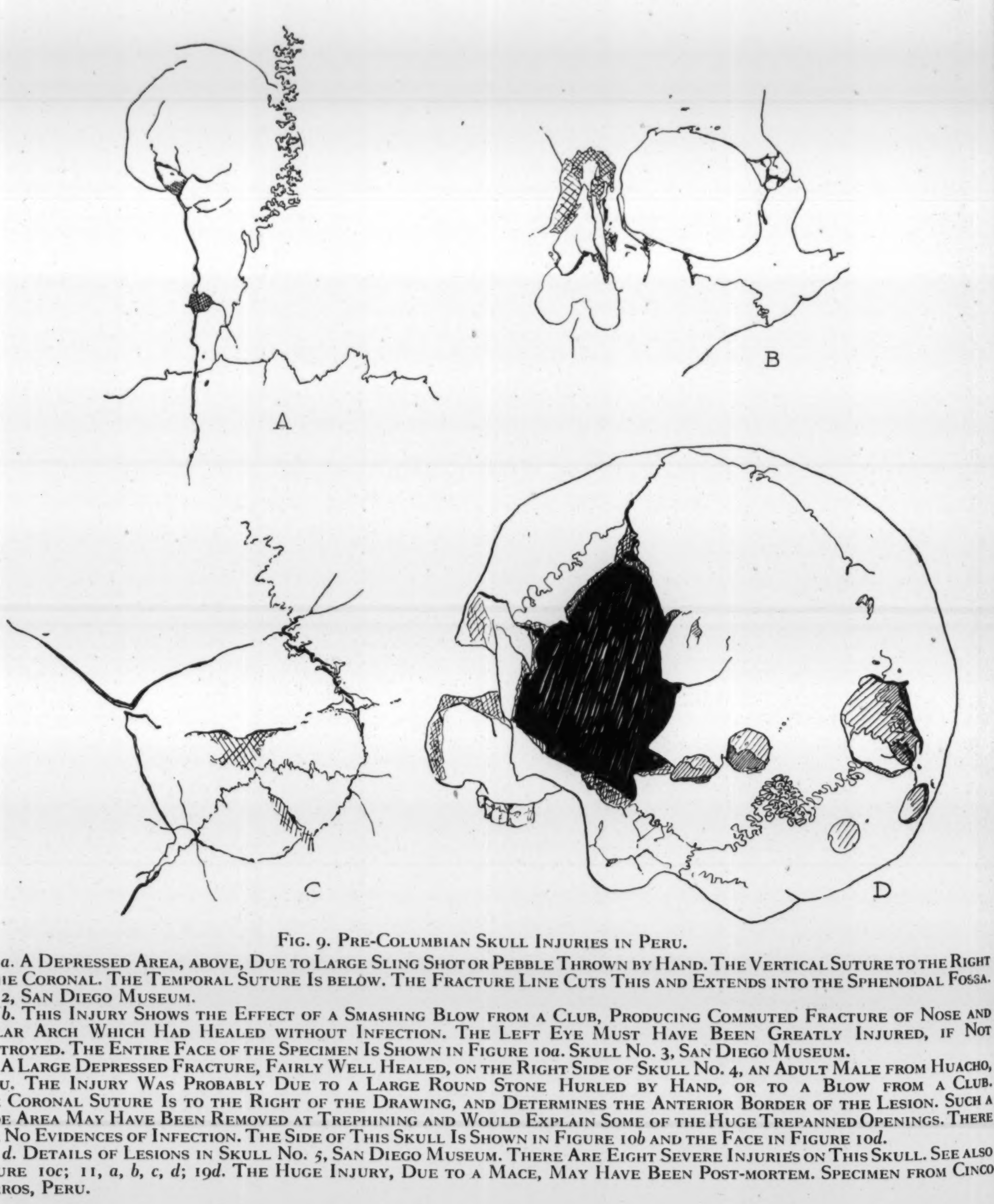


Fig. 9. Pre-Columbian Skull Injuries in Peru.

*a.* A Depressed Area, above, Due to Large Sling Shot or Pebble Thrown by Hand. The Vertical Suture to the Right Is the Coronal. The Temporal Suture Is below. The Fracture Line Cuts This and Extends into the Sphenoidal Fossa. No. 2, San Diego Museum.

*b.* This Injury Shows the Effect of a Smashing Blow from a Club, Producing Commuted Fracture of Nose and Malar Arch Which Had Healed without Infection. The Left Eye Must Have Been Greatly Injured, if Not Destroyed. The Entire Face of the Specimen Is Shown in Figure 10*a*. Skull No. 3, San Diego Museum.

*c.* A Large Depressed Fracture, Fairly Well Healed, on the Right Side of Skull No. 4, an Adult Male from Huacho, Peru. The Injury Was Probably Due to a Large Round Stone Hurled by Hand, or to a Blow from a Club. The Coronal Suture Is to the Right of the Drawing, and Determines the Anterior Border of the Lesion. Such a Wide Area May Have Been Removed at Trephining and Would Explain Some of the Huge Trepanned Openings. There Are No Evidences of Infection. The Side of This Skull Is Shown in Figure 10*b* and the Face in Figure 10*d*.

*d.* Details of Lesions in Skull No. 5, San Diego Museum. There Are Eight Severe Injuries on This Skull. See also Figure 10*c*; 11, *a*, *b*, *c*, *d*; 19*d*. The Huge Injury, Due to a Mace, May Have Been Post-mortem. Specimen from Cinco Cerros, Peru.

This skull doubtless represents a soldier, and a remarkable fighter. There are no less than eight severe injuries. The oldest and best healed of these was due to a smashing blow from a club across the nose, crushing it perfectly flat (Fig. 10*c*.) The nasal apertures are reduced to openings 10 mm. in diameter. There are seven depressed fractures on the occipital and parietal bones some of them well healed. The largest of these is on the inion measuring 38 mm. in diameter. Another one on the right occipital is perfectly round, measuring 15 mm. in diameter, both doubtless due to sling-shot injuries. On the left temporal (Figs. 9*d*; 11*c*) there is a huge opening 90 mm. in diameter, doubtless caused by a star-shaped mace, and was mortal. Two fracture lines extend anteriorly from this area. Altogether this individual shows a stubborn tenacity which could only be curbed by such smashing blows as seen here. (Figs. 9*d*; 10*c*; 11*a*, *b*, *c*, *d*.)

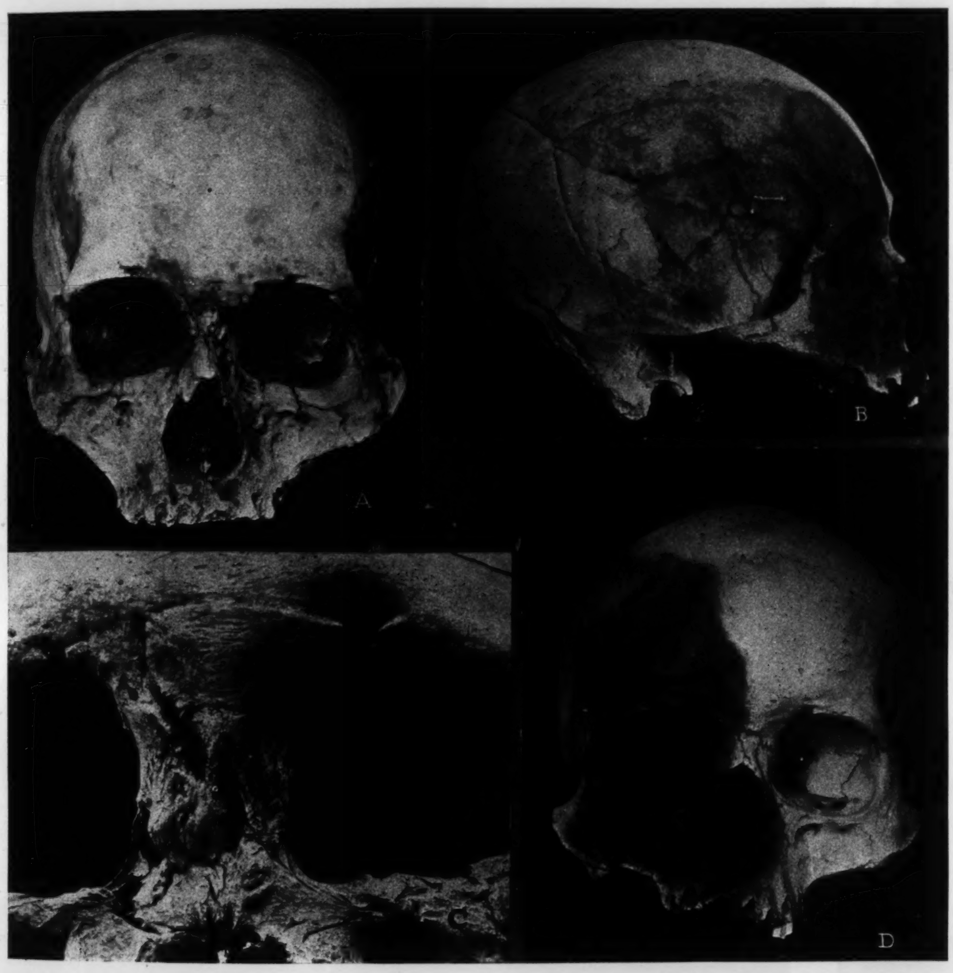


Fig. 10. *a*. Prehistoric Male Skull from San Damian, Peru, Showing in the Comminuted Nasal Bones the Effects of a Smashing Blow across the Left Eye with a Club. The Fractures Are All Well Healed. Skull No. 3, San Diego Museum. See Figure 9*b*.

*b* and *d*. Side and Face of a Prehistoric Male Skull No. 4 from Huacho, Peru, Showing Depressed Fracture, Well Healed, with a Fracture Line Running Circularly around the Lesion and Several Radiations. The Face *d* Shows the Effects of Weathering. The Dark Part Lay in the Soil and the Lighter Areas Exposed. See Figure 9*c*.

*c*. Details of the Flattened Nose of Skull No. 5 Showing the Effects of a Severe Smashing Blow with a Club across the Face. The Nose Is Well Healed and Is Perfectly Flat. See Figure 11, *a*, *b*, *c*, *d*.

No. 6. Prehistoric skull from Lomas, Peru. Male. Extensive fresh injury on left parietal and occipital bones.

The skull lay partially embedded in the soil. The right parietal and frontal are whitened and checked by exposure to the weather. The extensive injury on the left occiput was probably received during life, since there is evidence of dried blood on the fracture line near the left mastoid. This stain may have persisted over hundreds of years. The large opening has a diameter of 110 mm. There are four radiating fracture lines; one reaching the foramen magnum: one above the mastoid to the external auditory meatus; one through the temporal region, and one across the sinciput (Figs. 12*a*; 13*a*).

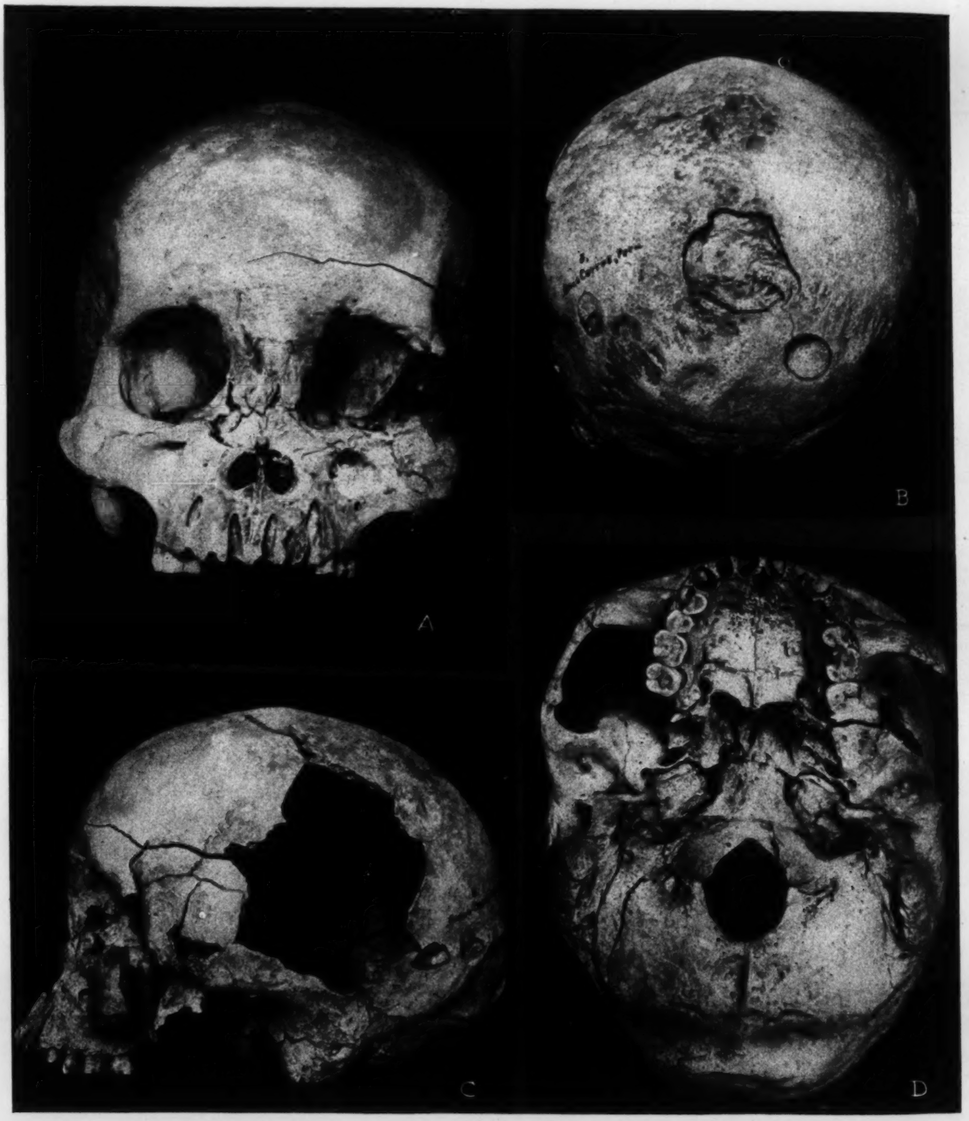


Fig. 11. Skull of a Pre-Columbian Soldier from Cinco Cerros, Probably an Ancient Fort, Near San Damian (See Fig. 4). A Much Abused Skull With Eight Severe Injuries. No. 5, San Diego Museum.

*a*. Face Showing Flattened Nose, and Frontal Fracture Running across the Forehead, Originating from the Huge Mace Injury on the Left (*c*).

*b*. Occiput Showing Mace Injuries and Old Scars Possibly Due to Sling-shot Wound.

*c*. Left Side Showing Huge Lesion and Two Small Depressed Fractures Due to Sling-shot Wounds. Malar Arch Possibly Broken at Excavation.

*d*. Base of Skull Showing Basal Fracture on the Left, Fractures Involving the Anterior Brain Case.

No. 7. Prehistoric skull from San Damian, Peru. Male. Old healed injuries on left malar and right occipital.

Edentulous. The left orbit is deformed by the injury seen on the malar. There is a well healed occipital injury represented by a depressed area 40 mm. in diameter. Its condition recalls cer-

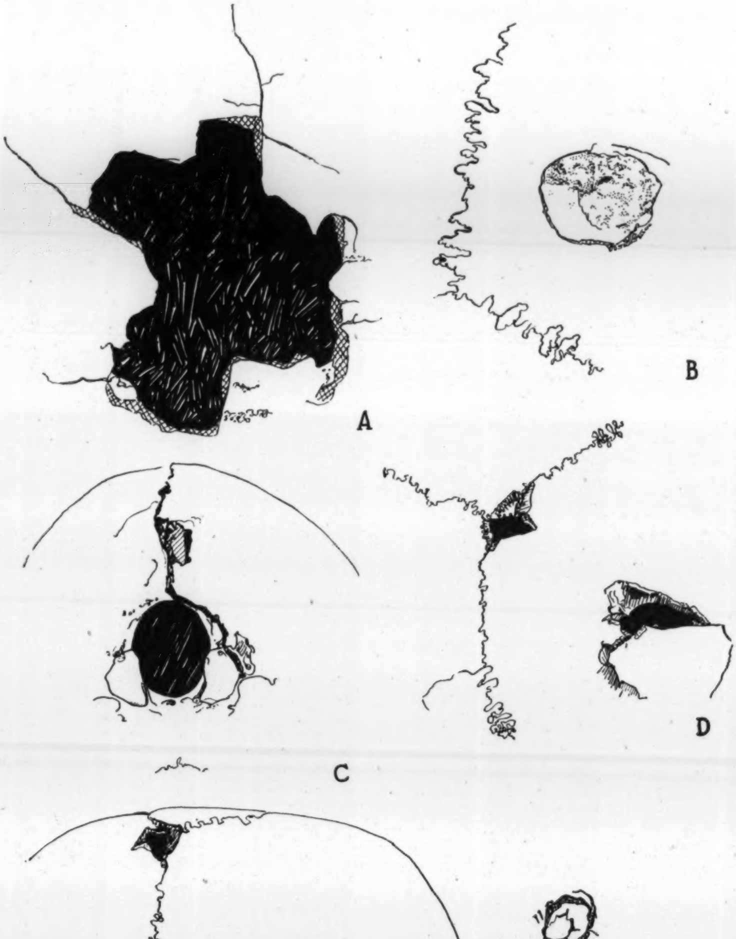


Fig. 12. Details of Pre-Columbian Head Injuries.

*a.* Huge Occipital Mace Injury. No Healing. Skull No. 6, Male from Lomas, Peru. Skull Shown in Figure 13*a*.

*b.* Depressed Fractured Area on Parietal of No. 15, a Prehistoric Female from San Damian, Peru. Skull in Figure 14*d*, and in *f* of This Figure.

*c.* Skull No. 16, a Prehistoric Female from San Damian, Peru, Showing Condition of Basal Fracture Due to Injuries on the Occiput Shown in Figure 22.

*d.* Skull No. 18, a Prehistoric Male from Cinco Cerros, Peru, Showing What Appear To Be the Only Evidences of a Sharp Implement, Such as a Sword, Being Used in Prehistoric Peru. The Lesion to the Right of This Figure (*d*) is Clearly Cut with a Sharp Thin Blade. This Skull Is also Depicted in Figure 13, *b* and *c*; and in *e* of This Figure.

*e.* The Effects of Angled Perforating Instruments in the Same Skull, Establishing a Plane of Weakness on Which the Huge Fracture Developed, as Shown to the Right. The Right Occiput Shows a Huge Club Injury.

*f.* Details of the Injury to a Prehistoric Female, No. 15, From San Damian, Peru, Showing Fracture Lines Following Impact of Sling-shot Stone above Orbit (See Fig. 14*b*).

tain denuded areas in examples of incomplete trephining. (Fig. 14*a*.)

No. 8. Prehistoric skull from Cinco Cerros, near San Damian, Peru. Male. Old healed injuries on the right maxilla and the left parietal. Perforating double abscess in left dental arch. (Fig. 14*c*.)

No. 9. Prehistoric skull from near Huarochiri, Peru. Female. Showing old healed injury of the left parietal and a scar on frontal.

No. 10. Prehistoric skull from Nasca Region, Peru. Female. Old healed injuries on right parietal.

The three healed injuries on the right parietal are doubtless perforated wounds due to arrows, or other sharp-pointed weapons. The inner skull table shows depression. The wounds healed without infection.

No. 11. Prehistoric skull from Cinco Cerros, near San Damian, Peru. Male. Extensive mortal injury to left occipital and mastoid.

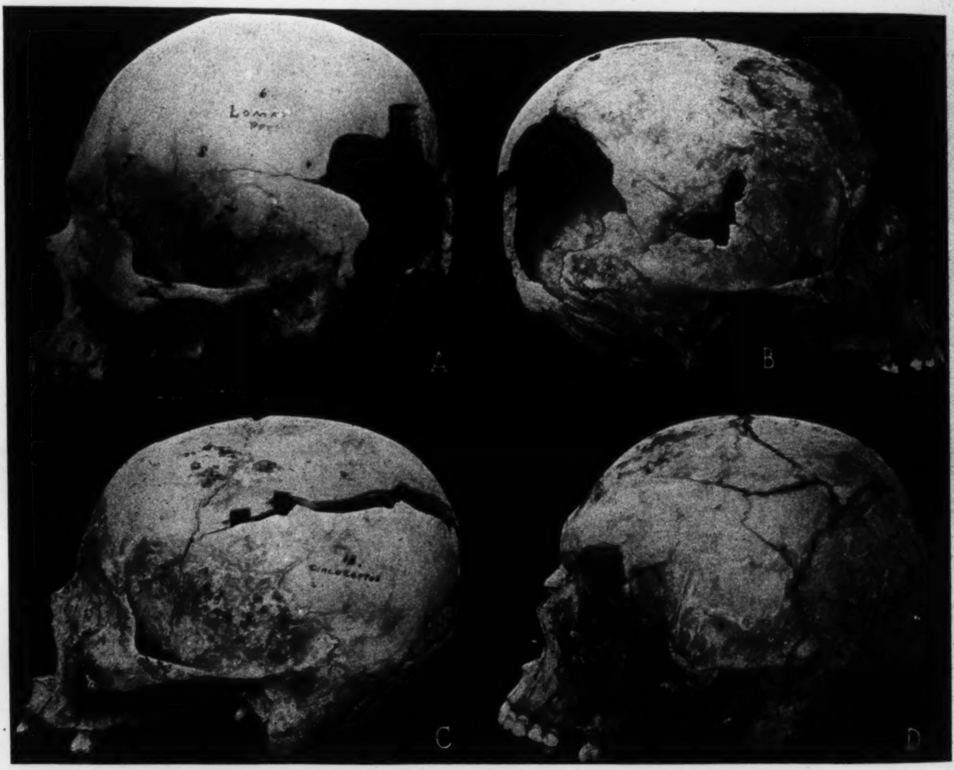


Fig. 13. Three Prehistoric Peruvian Skulls Showing Lesions Due to Violence.

*a.* Photograph of Skull No. 6, a Male from Lomas, Peru, Showing a Huge Occipital Lesion Due to a Blow from a Star-shaped Mace. The Details of This Lesion Are Shown in Figure 12*a*.

*b* and *c*. Right and Left Sides of Skull No. 18, a Male from Cinco Cerros, Peru, Showing Traumatic Lesions. This Skull Is Shown also in Figures 15*b* and 16*a*.

*d*. Left Side of Skull No. 21 from San Damian, Peru, Showing Fractured Vault and Injured Malar Region.

Injury probably due to star-shaped mace (Fig. 15*a*).

No. 12. Prehistoric skull from near San Damian, Peru. Male. Old perforating injury above and including a part of the left orbit, with signs of healing.

No. 13. Prehistoric skull from Chilca, Peru. Female, old healed injury on frontal.

Skull otherwise perfect. All sutures clear, with numerous Wormian bones in the occipito-parietal suture. Skull rather heavy. Parietals and occipital show evidences of recovery from osteoporosis, a nutritional disease of infancy. The openings are healed but the bones are still somewhat thickened. The inner skull table is not affected.

No. 14. Prehistoric skull from San Damian, Peru. Female. Injuries of vault.

There are four rounded perforations (Fig. 15*d*) on the vault, varying in diameter from

5 mm. to 18 mm. All of them are circular, and two show depressed fracture fragments. All of the lesions may have been due to sling-shot injuries, or perforations by cylindrical arrow points. All are unhealed. The skull vault is very thin.

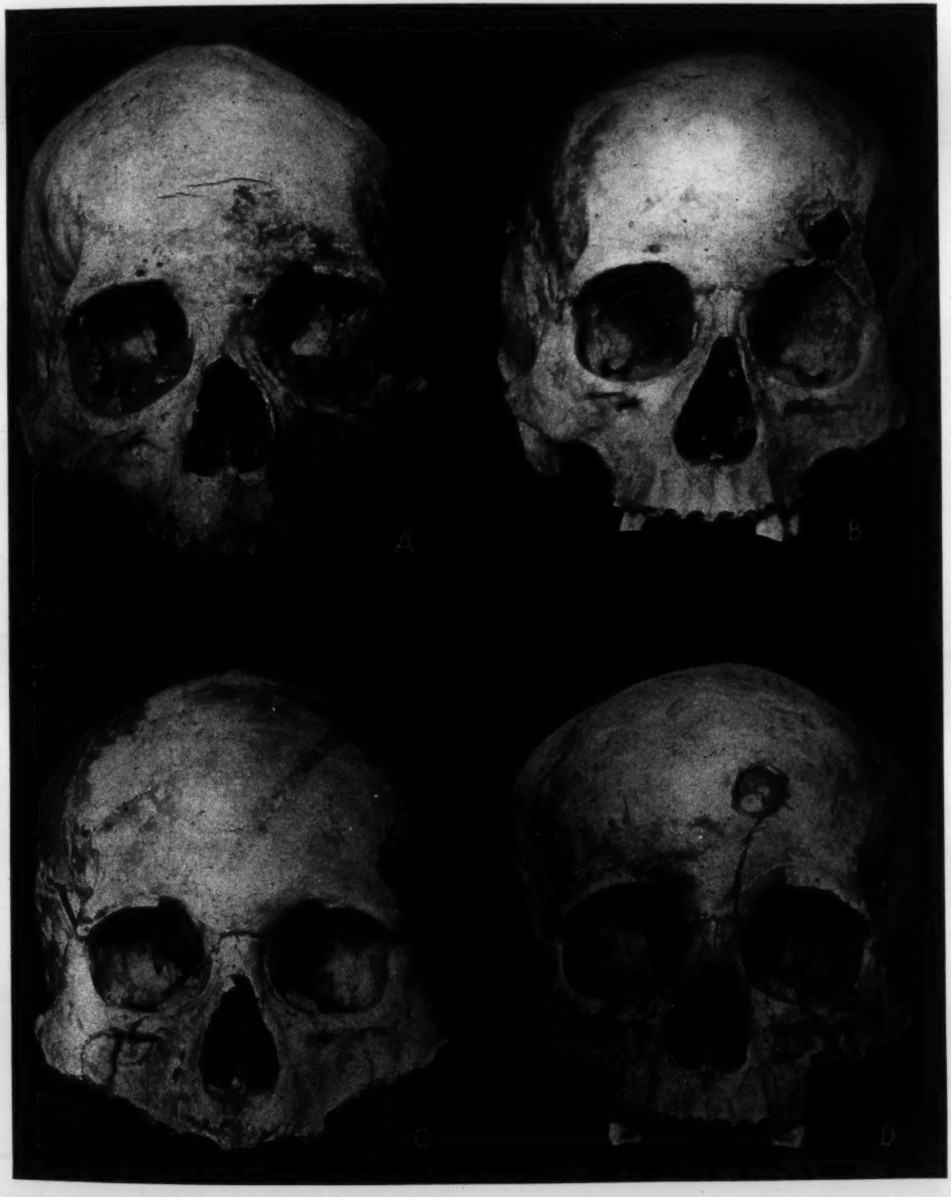


FIG. 14. PREHISTORIC SKULLS FROM PERU, SHOWING EFFECTS OF SENILITY IN *a* AND IN *c*; A PERFORATING LESION IN *b* AND A SLING-SHOT INJURY WITH FRACTURE LINE IN *d*. THIS IS ALSO SHOWN IN FIGURE 12*f*. THE TWO SENILE SKULLS SHOWN IN *a* AND IN *c* SHOW THE EFFECTS OF LONG HEALED INJURIES.

*a*. SKULL NO. 7, MALE FROM SAN DAMIAN, PERU.
*b*. SKULL NO. 12, PREHISTORIC MALE FROM SAN DAMIAN, PERU.
*c*. SKULL NO. 8, SENILE MALE FROM CINCO CERROS, PERU.
*d*. SKULL NO. 15, PREHISTORIC FEMALE FROM SAN DAMIAN, PERU.

No. 15. Prehistoric skull from San Damian, Peru. Female. Characteristic sling-shot injury in frontal.

A circular depressed area 15 mm. in diameter, almost in the center of the forehead. The bone is fractured in a curved line (Figs. 12*b* and *f*; 14*d*) down to the frontomaxillary suture. There are no evidences of healing. Another depressed and fractured area in the right parietal may have been due to a blow from a rounded stone. The fractured malar of the left side has no apparent relation to either injury.

No. 16. Prehistoric skull from near San Damian, Peru. Female. A number of sling-shot or mace-point injuries in the frontal, parietal and occipital.

The vault of this skull is papyraceous, the frontal bone measuring a scant 2.5 mm. in thickness; the temporal quite thin and paper-like.

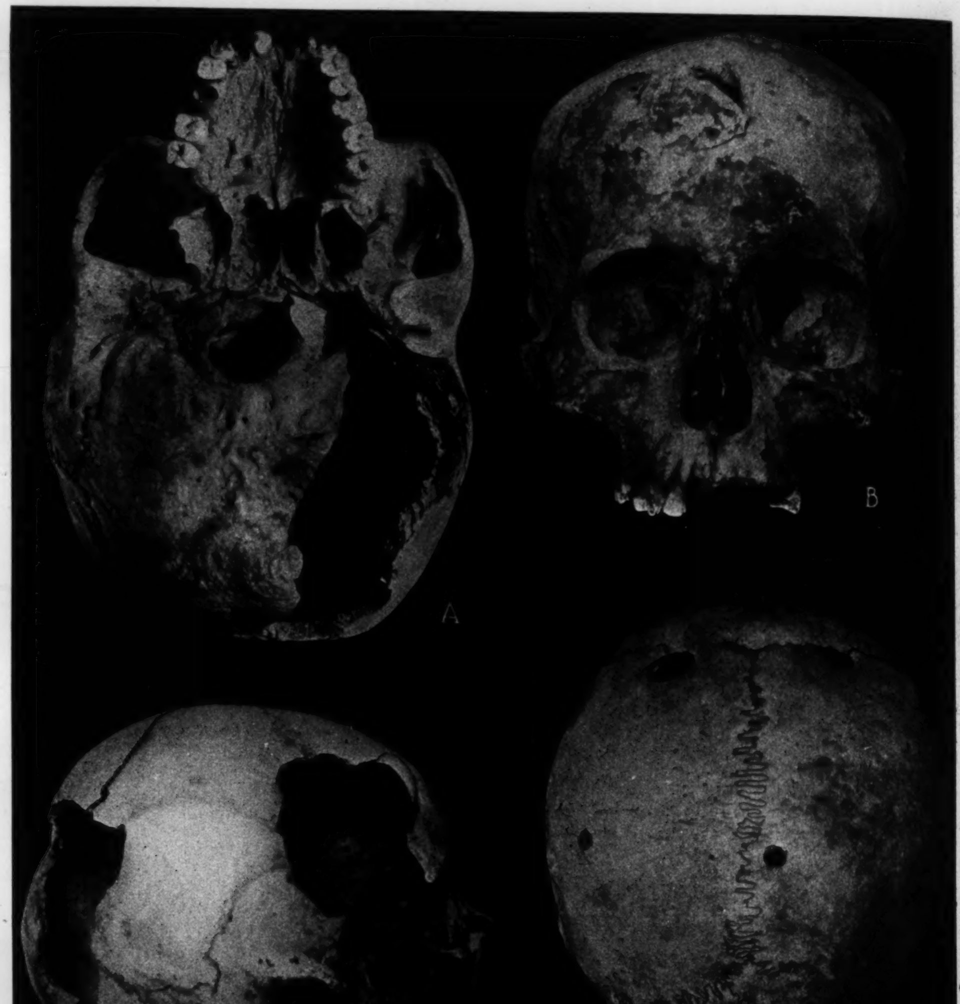


FIG. 15. FOUR PREHISTORIC SKULLS FROM PERU SHOWING VARIOUS TYPES OF LESIONS.
*a.* SKULL NO. 11, MALE FROM CINCO CERROS, PERU, SHOWING EXTENSIVE MORTAL INJURY IN LEFT OCCIPUT.
*b.* SKULL NO. 18, MALE FROM CINCO CERROS, PERU, SHOWING EFFECTS OF AN INJURY IN THE FOREHEAD DUE TO A SHARP, SWORD-LIKE INSTRUMENT. A RARE TYPE OF LESION. THERE ARE SEVEN OTHER INJURIES IN THIS SKULL. (SEE FIGS. 13, *b* AND *c*; 15*b*, 16*a*.)
*c.* TWO HUGE OPENINGS APPARENTLY MADE BEFORE DEATH. A FEMALE. NO. 23, FROM CINCO CERROS, PERU.
*d.* SKULL NO. 14, PREHISTORIC FEMALE FROM SAN DAMIAN, PERU. LESIONS DUE TO SLING SHOT OR CYLINDRICAL ARROW POINTS. SKULL BONES VERY THIN. THE FOUR LESIONS MEASURE FROM 5 MM. TO 18 MM. IN DIAMETER.

The injuries are shown in Figs. 12*c* and 22. Injuries to the vault seem to have produced no greater skull defects than in those of greater thickness. There are four injuries in the occiput; a rounded opening in the posterior part of the right parietal 15 mm. in diameter. A huge right temporal lesion 60 mm. × 35 mm. Three injuries are in the sagittal line, which on account of their irregular shape may have been due to a mace injury. An extensive fracture line has resulted from these injuries. From the inion the line runs directly to the foramen magnum, at which place it is joined by a fracture extending to the right occipital condyle. The other independent injury is in the right temporal region, extending from the right mastoid to the eminence above the right orbit. This was evidently a mace injury of large proportions. Had the skull been thicker there would probably have been more fractures, but in this thin eggshell-like cranium the weapon smashed right through. None of the injuries were healed.

The much battered skull of this young woman does not speak highly of the pre-Columbian Indian's idea of chivalry.

No. 17. Prehistoric skull from the coast of Peru. Female. A large osteoma on the occipital near left asterion.

Unless the large mamillary osteoma was due to an injury the skull is not otherwise affected.

No. 18. Prehistoric skull from Cinco Cerros, near San Damian Peru. District of Huarochiri. Male. Extensive injuries of the vault by cutting and perforating weapons.

This skull may be from the period of the Conquest and the lesions due to sharp instruments may be sword cuts.

There are eight open lesions made by perforating, cutting, and club-like weapons on the vault, shown in Figures 12*d*, and *e*; 13*b* and *c*; 15*b*; 16*a*. None of the lesions show marked evidences of healing. The injury to the frontal bone is a large one, measuring 42 mm. in long diameter. The injury is quite unusual, if not quite unique, in showing the effects of a cutting weapon, such as a sword, recalling the sword cuts figured by Dr. F. Wood Jones in his study of ancient Egyptian pathology.

There are six angular, perforated lesions undoubtedly made by a polyhedron-shaped spear, or arrow. Two of the openings occur immediately above the temporal suture in the left parietal. The most anterior one is definitely rectangular, measuring 6 mm. × 8 mm. From these openings runs an extensive fracture line to the sinciput, where it joins another angulated perforating injury, and then on to the huge skull defect in the right parieto-occipital region. There is another perforating, angular injury exactly at the bregma. A blow from a club could have been responsible for the huge defect, measuring 60 mm. × 90 mm. A fracture line connects this defect with the coronal suture.

All of these small, angular openings show oblique fracturing of the inner skull table. A single opening shows a similar kind of fracture in the outer skull table, as if the weapon had penetrated the skull and then been violently withdrawn. On the occipital there are a number of injuries. One perforating injury 6 mm. in diameter, and a number of fracture lines around the foramen magnum, associated with the huge crushing blow, of the right occiput.

No. 19. Prehistoric skull from Lomas, Peru. Male. Injuries.

A large, circular opening, 25 mm. in diameter, is found immediately above the temporal ridge, on the coronal suture, evidently due to the impact of a large sling-shot stone. Above the opening there are several pieces of bone, liberated by the depressed fracture. From the opening there are three extensive fracture lines. One running down into the temporal fossa and joins another injured area. However, I regard this and the injury seen below the right orbit, as due to post-mortem injuries. See Figure 16*c*.

No. 20. Prehistoric skull from Huacho, Peru. Child. Injuries by sling shot, or dull mace point, in frontal.

This juvenile skull, of about eight years of age, shows three rounded, depressed areas and clean-cut perforations, about 15 mm. in diameter. Two on the left frontal, and one in right temple on coronal suture.

No. 21. Prehistoric skull from near San Damian, Peru. Male. Extensive injuries.

On the right parietal is a depressed, fractured area, 50 mm. in long diameter, due apparently to a blow from a thin stone hatchet or copper axe (Fig. 13*d*). The margins of this opening are badly fractured, as if the weapon were somewhat blunted. The left parietal is badly fractured, evidently from a fall in which the individual struck his head against a smooth rock causing the coronal suture to open, and producing a number of extensive fracture lines, one of which extends down to the mastoid.

No. 22. Prehistoric skull from Pueblo Viejo, San Damian, Peru. Child 5 or 6 years old. Extensive, largely healed injury of the vault, with a depression of the left temporoparietal region and radiating fractures in frontal and both parietals.

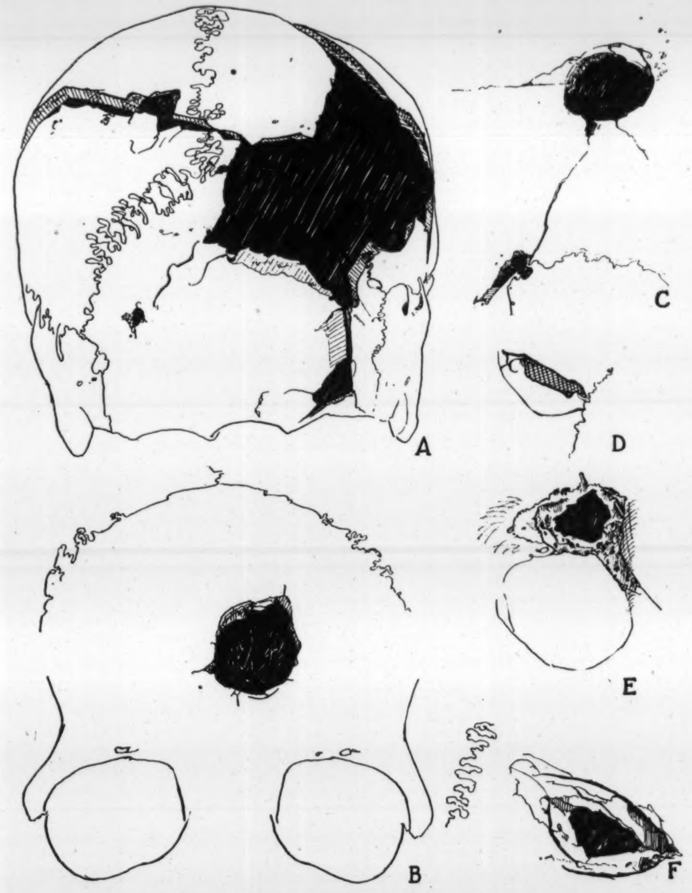


Fig. 16. Details of Injuries on Pre-Columbian Skulls.

*a.* Skull No. 18, Male from Cinco Cerros, Peru. Shows Extensive Fracturing from the Huge Lesion on the Right Due to a Mortal Blow from a Star-shaped Mace. This Skull Is also Shown in Figures 12, *d* and *e*; 13, *b* and *c*; 15*b*.

*b.* Skull No. 26, Male from Cinco Cerros, Showing Effects of Penetrating Wound by Sling Shot in Frontal.

*c.* No. 19, Male, Showing Penetrating Effect of Large Sling Shot in Temple, Producing Radiating Fracture Lines.

*d.* No. 24, a Female from Valley of Chicama, Peru, Showing the Effects of a Blow from a Thin-bladed Copper Axe.

*e.* No 12, Male from San Damian, Showing Old and Partly Healed Injury above Left Orbit.

*f.* No. 21, Male from Near San Damian, Showing a Fractured Area on the Right Parietial, 50 mm. in Length, Due to a Blow from a Blunt Stone Implement. The Depressed Area Recalls Very Strongly Some of the War Injuries Described and Figured by Cushing.

No. 23. Prehistoric Skull from Cinco Cerros, Peru. Female. Extensive crushing injuries on the right in front and back. See Figure 15*c*.

The bones of the skull, bleached white, are very thin. The two huge openings in this skull by their nature and the condition of the bones seem to have been received before death. The shapes of the opening and the nature of the depressed fracture lines indicate the use of a small star-shaped mace with rounded points. One blow hit the woman immediately behind and above the right orbit breaking away nearly all maxillary bone of that side, part of the frontal, part of the parietal and temporal bones. Nearly all of the fractured margins are oblique internally.

The posterior opening is largely confined to the right parietal. From this opening extend large and long fracture lines; one of them running completely across the right parietal. While the greatest damage was done to the parietal bone yet at the inion is a depressed fracture area which indicates that one mace point went completely through the skull bone.

No. 24. Prehistoric skull from Valley of Chicama, Peru. Female. Wound in frontal produced in all probability by a copper axe. Arthritic condition of the left glenoid fossa (Fig. 16*d*).

The opening in the frontal bone is a sharply defined, clean-cut injury, made by a sharp edged tool, producing also on one side a depressed fracture. There are no evidences of infection or healing and death probably ensued shortly after the blow was struck.

The left glenoid fossa shows a marked arthritic area, 18 mm. long and 12 mm. wide. The margins of the area are indicated by a crinkled outline of new bone. The articular area itelf is somewhat eburnated, but the posterior one-half of the surface is cancellous. The osteophytic margin projects above the bone of the fossa, with three minute, isolated areas of new bone.

No. 25. Prehistoric skull from Nasca Region, Peru. Female. An old healed impressed wound in the upper and anterior angle of the right parietal.

No. 26. Prehistoric skull from Cinco Cerros. Peru. Male. Injuries probably by a large sling-shot in the frontal (Fig. 16*b*).

Since the margins of the injury show no evidences of either healing or infection the wound was probably fatal.

No. 27. Prehistoric skull from Matucana, Peru. Female. Two mace point impressions in the occipital.

Three injuries appear on the occipital bone of this skull. One of them may be from a sling shot and the other a star-shaped mace. The most severe injury is seen immediately below the parieto-occipital suture. The depressed area measures 13 mm. in diameter, and is almost circular. This injury produced a fracture line running downward over the occipital for a distance of 36 mm. and then bifurcating. Except for the occipital injuries the skull is otherwise in perfect condition.

No. 28. Prehistoric skull from San Damian, Peru. (Locality shown in Fig. 4.) Female. Old depressed, healed wound, probably due to a sling shot, in the posteroinferior angle of the left parietal.

Injury healed without infection. The edentulous palate shows evidence of long-standing osteophytes developed in response to long-continued use of the palate as a masticating surface.

No. 29. Prehistoric skull from Chilca, Peru. Female. Old scar in the forepart of the right parietal.

The skull is badly checked by weathering. The old lesion is completely healed over, leaving a smooth, depressed area.

No. 30. Prehistoric skull from Cinco Cerrors, Peru. Male. Extensive fracture, probably by a club, in the left temporoparietal region (Fig. 17*a*).

The injury lies immediately above the mastoid; fracture lines extend across the occipital to the right parieto-occipital suture. Another fracture line extends to the foramen magnum. A curved fracture follows the direction of the inferior temporal line. A large irregular piece of bone is lost from the skull. The injury was doubtless fatal since there are no signs of healing or infection. This heavily muscled individual was undoubtedly a soldier.

No. 31. Prehistoric skull from San Damian, Peru. Female. Number of perforating wounds, with one large, crushing injury in the back (Fig. 17*b*).

On the frontal bone there are two well-healed scars; one almost circular, and the other oval. Both are probably due to sling-shot injuries. On the lower part of each parietal there are two openings, the largest of which has a diameter of 18 mm.; the other three being uniform in shape with an average diameter of 9 mm. Only one shows any evidence of healing. All of these perforating injuries are doubtless due to sling shot. Almost the entire occipital was carried away by a crushing injury from some heavy weapon. The posterior half of the foramen magnum and the right mastoid were torn away. The probability of this being an ante-mortem injury is substantiated by the oblique and inwardly directed margins of the opening. Two large radiating fracture lines extend from the borders of this injury; in one case entirely across the parietal, and the other across the temporal.

No. 32. Prehistoric skull from Coyungo, Nasca Region. Peru. Old healed injury on the frontal and left parietal.

This skull, probably a mature male, shows on the left two-thirds, extensive effects of weathering. This prevents an adequate interpretation of the lesion in the left parietal, which was apparently well healed. The parietal bone appears to be exceptionally heavy and is thickened around the point of injury. It is impossible to say what type of weapon produced this V-shaped injury. The wound originally was a depressed fracture, but the edges are all overgrown with new bone, except at one point where there is a cleft-like opening into the endocranial cavity. The area was not sufficiently depressed to produce unpleasant and untoward symptoms.

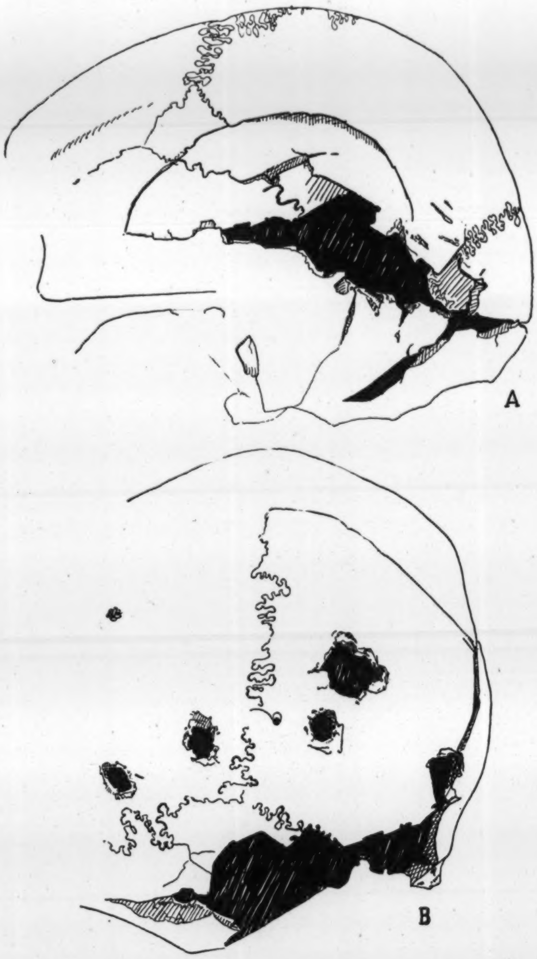


Fig. 17.

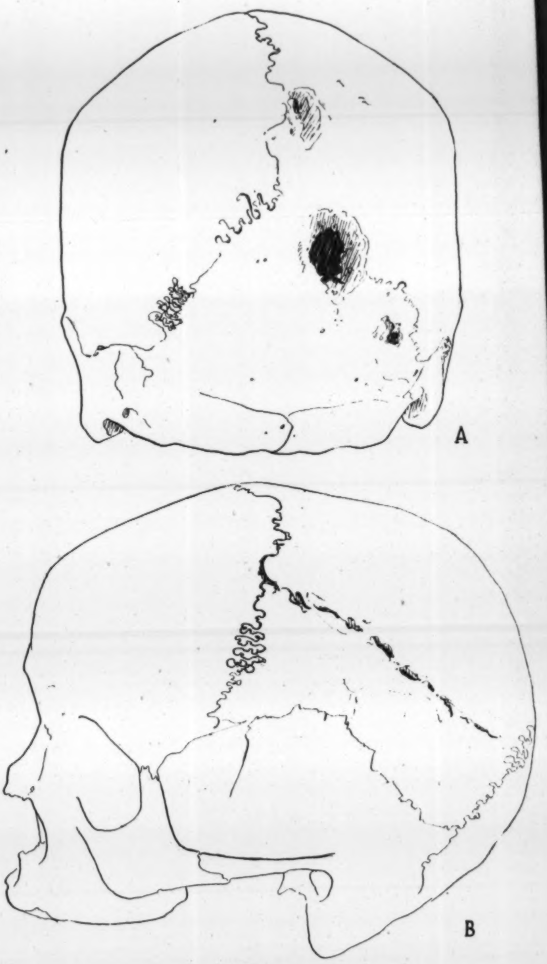


Fig. 18.

Fig. 17. *a.* Skull No. 30, Representing a Well-muscled Soldier Whose Death was Due to a Blow from a Club Producing the Severe Fractures Shown.

*b.* A Female Skull, No. 31, Showing Several Penetrating Wounds on the Occiput. The Large Lesion was Doubtless Due to a Well-aimed Blow from a Heavy Mace Since It Carried Away Nearly the Whole of the Occipital Bone. Healed Scars Are Seen on the Frontal Bone.

Fig. 18. *a.* The Occiput of Skull No. 36, Showing Healed Perforating Lesions. No Injury to Inner Skull Table. Healing without Infection.

*b.* A Male Skull, No. 37, Showing a Healed Fracture Extending across the Parietal.

---

Fig. 19. *a.* Skull No. 42, a female From Huacho, Peru, Showing Effects of Two Perforating Injuries and a Huge Defect Due to a Crushing Blow. No Infection.

*b.* The Association of Fractured Area and Incomplete Trephining by the Very Rare Method of Drilling. The Eight Incomplete Drillings Show Smoothed Edges as if the Surgical Wounds Had Begun to Heal before the Fracture, to the Left and Adjoining the Suture, Had Been Received. None the Less Here Is an Undoubted Area Showing the Association of Surgical Work and Injury. A Female Skull, No. 283, From Matucana, Peru.

*c.* Skull No. 299, from Cinco Cerros, Peru. Male, Showing Healed Facial Bones.

*d.* Roentgenogram of Skull No. 5, a Male Skull Shown also in Figures 9, 10 and 11.

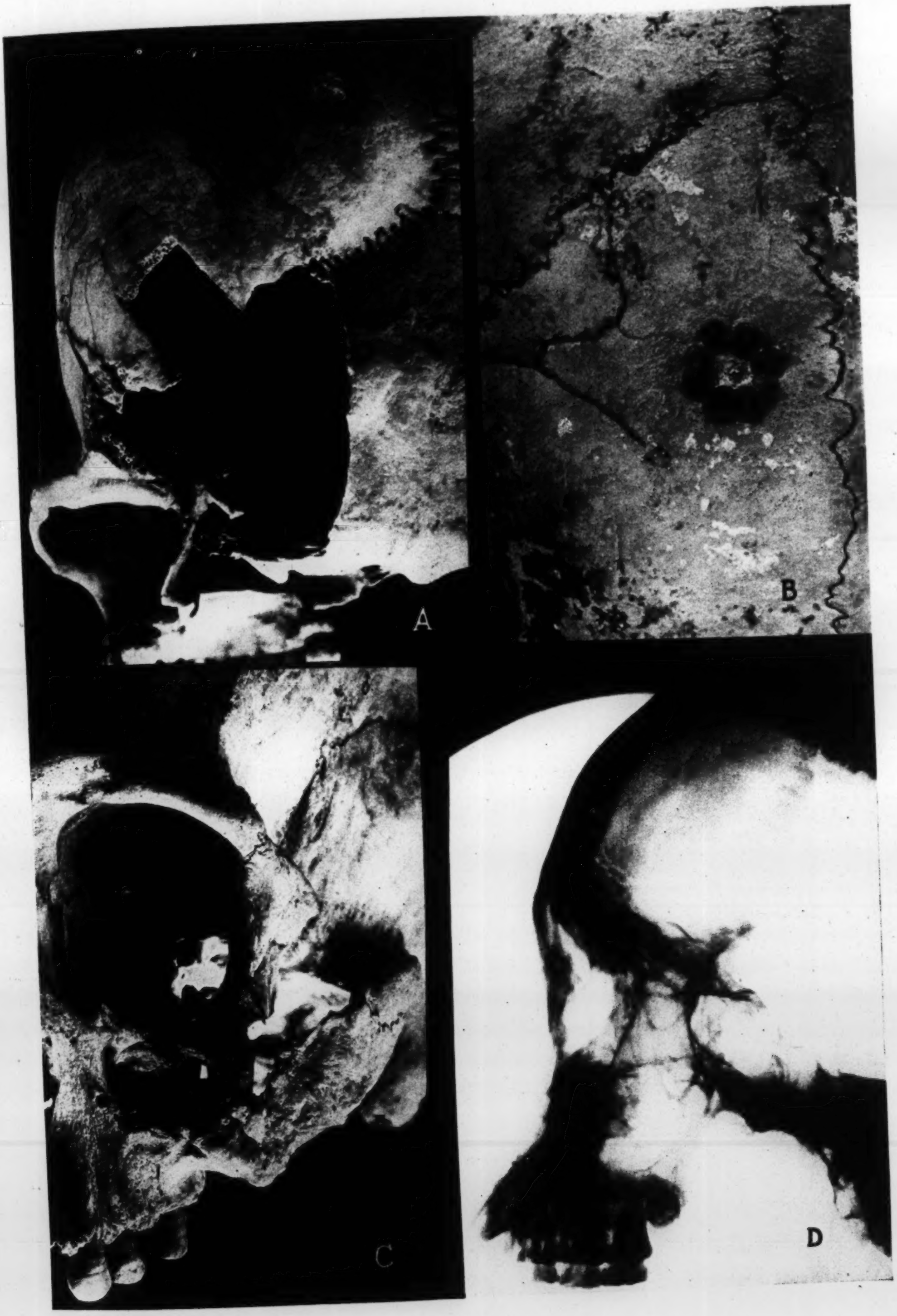


Fig. 19.

Hence no attempt had been made at trephining, for it was doubtless just such injuries the correction of which brought about the surgical interference of trephining. Thirty mm. above the right orbit there is a circular depression, 15 mm. in diameter, completely healed and doubtless due to a sling shot.

No. 33. Prehistoric skull from San Damian, Peru. Male. Extensive old injuries of the facial parts.

This elderly male had received a long time before death a heavy crushing injury to the nose, involving the frontal bone and both orbits. The face was completely flattened. The injury doubtless became heavily infected, for there are numerous osteophytes developed and the healed fragments of bone are somewhat thickened.

The palate carries but one tooth, and the roots of that show evidences of alveolar absorption. The hard palate, as in so many primitive and edentulous persons, shows low osteophytes, the growth of which was undoubtedly stimulated by chewing hard, tough food with the gums.

No. 34. Prehistoric skull from Nasca Region, Peru. Female. Two old perforating injuries on left parietal, with an old scar on right parietal.

No. 35. Prehistoric skull from Pueblo Viejo, near San Damian, Peru. Male. Depressed injury of the frontal. Underneath old extensive wound of the lower part of the orbit, and adjoining parts of the face.

No. 36. Prehistoric skull from Nasca Region, Peru. Two perforating and one depressed injury along the posterior border of the right parietal (Fig. 18*a*).

This is a very unusual skull and may be post-Columbian since one of the lesions shows definite evidence of having been due to a sharp-edged tool, possibly a Spanish sword. None of the injuries show evidence of internal depression, but have more the appearance of trephine wounds, produced by scraping. One of the lesions is completely healed. Another, with a wide (15 mm.) sloping border shows an oval hole from the margins of which project low osteophytes.

No. 37. Prehistoric skull from Lupo, near Huarochiri, Peru. Male. Extensive healed fractures across both parietals (Fig. 18*b*).

The fractures present on this skull are extremely unusual. They appear as backwardly directed lines across both parietals. The injury was doubtless due to a glancing blow on the left parietal eminence, producing a fracture line 190 mm. long, which had healed without infection. The coronal suture separated and the skull cap was lifted by the force of the blow, producing on the right side below the parietal eminence another fracture line 80 mm. long, which is also perfectly healed without infection. The skull is that of a large middle-aged male, with an unusually well-proportioned cranium.

No. 38. Prehistoric skull from Cinco Cerros, Peru. Male. Old injuries on various parts of the face.

No. 39. Prehistoric skull from Pachacamac, Peru. Male. Old injury from a sling shot or mace point, left frontoparietal region.

No. 40. Prehistoric skull from San Damian, Peru. Female. Remains of ancient incomplete trephining, by abrasion, on the left parietal (Fig. 20*a*).

No. 41. Prehistoric, or early historic, skull from Lomas, Peru. Male. Two old healed injuries on top of the head, probably by a mace. Large fresh injury of vault and facial parts on the left, probably by a club (Fig. 20*c*).

The enormous injury to the left resulted in the destruction of about one-third the entire skull, involving the jugal arch, the mastoid, the occipital, parietal, frontal and sphenoid bones. In some places the margins of the wound seems smooth, as in cases of bone healing, but since it is incredible that such an extensive injury was not mortal it may well be that these edges were produced by wind-blown sand, since the skull had been exposed to the weather for a period of years. A semicular fractured area to the left of the bregma, indicates that the destructive blow may have been due to a mace.

No. 42. Prehistoric skull from Huacho, Peru. Female. Perforating and crushing injuries of the back on the left side (Fig. 19*a*).

Three injuries occur on the left occipitoparietal resulting in the loss of the left mastoid. Two of the lesions are perforating, sling-shot wounds, with clearly marked borders. The other is an extensive wound, 65 mm. × 80 mm. in extent, produced by a blow from a club. In the left parietal several fragments of bone remain attached to the skull.

No. 45. Prehistoric skull from Lomas, Peru. Female. Old healed injuries over the posterior part of both parietals (Fig. 21*a*).

No. 46. Prehistoric skull from San Damian, Peru. Female. Old healed injury on the right side of the frontal (Fig. 20*b*).

No. 47. Prehistoric skull from Nasca Region, Peru. Male. Perforating healed injury in the posterosuperior angle of the left parietal and a similar one on the left side of the occipital.

No. 48. Part of a prehistoric skull from Huacho, Peru. Two small perforating injuries of the occipital. No healing.

No. 49. Part of a prehistoric skull from Huarochiri, Peru. Child. Perforating injury to the occipital (14 mm. in diameter). No healing (Figs. 21*b* and *c*).

No. 50. Part of a prehistoric skull from Lomas, Peru. Female. Old and recent wound in the left parietal (Fig. 20*d*).

The opening measures 25 mm. × 35 mm. The effects of the injury on the inner skull table are shown. Near the opening is an old, healed injury.

No. 52. Part of a prehistoric skull from Huacho, Peru. Perforating injury made by some small, pointed, angular object in the right parietal (opening 10 mm. in diameter).

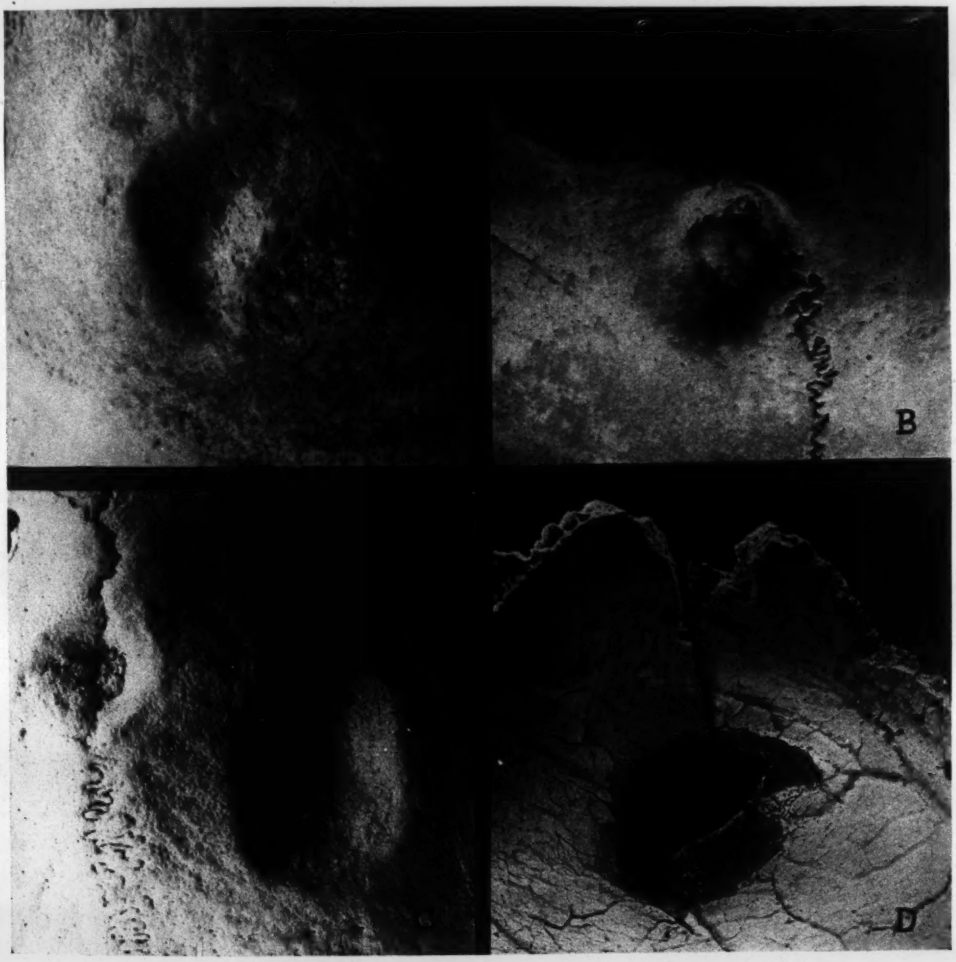


FIG. 20. DETAILS OF SOME DEPRESSED FRACTURES, HEALED AND UNHEALED.

*a.* SKULL NO. 40, A FEMALE, SHOWING ALSO RESULTS OF INCOMPLETE TREPHINING ON ANOTHER PART OF THE SKULL. INJURY DOUBTLESS DUE TO SLING-SHOT WOUND.

*b.* SKULL NO. 46, A FEMALE FROM SAN DAMIAN, PERU, ALSO SHOWING INJURY. LESION WELL HEALED.

*c.* SKULL NO. 41, A MALE FROM LOMAS, PERU, SHOWING THE HEALED EFFECTS OF TWO DEPRESSED INJURIES, DUE TO SLING SHOT.

*d.* SKULL NO. 50, A FEMALE FROM LOMAS, PERU, SHOWING THE EFFECT ON THE INNER SKULL TABLE OF A PENETRATING SLING-SHOT INJURY.

No. 53. Part of skull from Coyunga, near Nasca, Peru. Male. Large perforating injury in the frontal, with signs of inflammatory reaction on the ventral surface.

The skull bones are greatly thickened. The inner skull table is softened and cancellous, as in osteoporosis, but due to an infected blood-clot. Skull much weathered.

No. 55. Prehistoric skull from Coyungo, near Nasca, Peru. Female. Remarkable extensive and healed injuries on both sides of the frontal, as well as in both parietals.

Figures of this skull will accompany the paper on surgery, Studies in Paleopathology XXII. One of the lesions looks remarkably like an attempted bone transplant.

The injuries to the parietal are quite superficial and are confined entirely to the outer skull table. The skull is badly weathered so that the external characters of the remarkable injury to the left frontal are not clearly shown. An examination of the interior of the skull reveals a most interesting condition. It would seem from all evidences that the lesion is a healed, depressed fracture, but it also looks as if a prehistoric surgeon had attempted a bone transplant and had succeeded. The lesion is 40 mm. in diameter and from it extends a fracture line running posteriorly for a distance of 50 mm. The inner skull table at the asterion has been badly infected and there is an eroded area 20 mm. × 30 mm. extending backwards on to the parietal along the fracture line. On the opposite side of the frontal there is another injury the external appearance of which curiously resembles the figure 5. Internally it presents the characters of a well-healed depressed fracture.

No. 56. Part of a prehistoric skull from Chavina, Acari Valley, Peru. Male. Marked artificial deformation (flat head). Large old healed injury of the frontal.

No. 61. Part of a prehistoric skull from Coyungo, Nasca Region, Peru. Old healed and a recent unhealed impression in the right parietal.

No. 62. Part of a prehistoric skull from Chavina, Acari Valley, Peru. Male. Large old scar on the frontal.

No. 63. Part of a prehistoric skull from Coyungo, Nasca Region, Peru. Old perforating healed wound in right parietal, possibly due to sling shot.

No. 64. Part of prehistoric skull from near Nasca, Peru. Male. Old injury, probably by a copper axe, across the frontal, with fractures. Healed fracture line extends down into right orbit. Injury confined to outer skull table. The weathering to which the skull has been exposed obscures some of the details. Fracture line 60 mm. long.

No. 69. Part of prehistoric skull from Nasca Region, Peru. Impressed healed wound in left parietal, due to sling shot.

No. 70. Part of prehistoric skull from Nasca Region, Peru. Impressed healed wound in the right parietal.

No. 71. Part of prehistoric skull from Coyungo, Nasca Region, Peru. Male. Old healed injury in the frontal.

No. 72. Part of a prehistoric skull from Lomas, Peru. Old impressed healed wound in the left parietal.

No. 73. Part of prehistoric skull from Lomas, Peru. Male. Old healed injury in the right part of the frontal. Excessive absorption of dental arch on left.

No. 74. Part of prehistoric skull from Huacho, Peru. Male. Old healed injury over the right frontal sinus.

This opening may have been trephined to drain an abscess in the frontal sinus, or it may have been caused by a depressed fracture.

No. 75. Part of prehistoric skull from Chavina Peru. Female. Pronounced frontal compression (flat head). Old healed injury in the frontal.

No. 76. Part of a prehistoric skull from Nasca Region, Peru. Adolescent. Old healed perforating wound in left parietal.

No. 77. Part of a prehistoric skull from Coyungo, Peru. Female. Old healed wound in the left parietal eminence.

No. 80. Part of a prehistoric skull from Lomas, Peru. A depressed, healed injury at the lambda; a scar on the left parietal.

No. 82. Part of a prehistoric skull from Ancon, Peru. Old healed injury in frontal.

No. 83. Part of a prehistoric skull from Lomas, Peru. Female. A healed injury over left orbit.

No. 84. Part of a prehistoric skull from Lomas,

Fig. 21. *a*. Skull No. 45, a Female Showing Many Healed, Depressed Fractures on the Occipitals and Parietals. Doubtless Sling-shot Injuries.

*b* and *c*. Skull No. 49, Child's. Showing Outer and Inner Aspects of Penetrating Wound in the Occipital. No Healing.

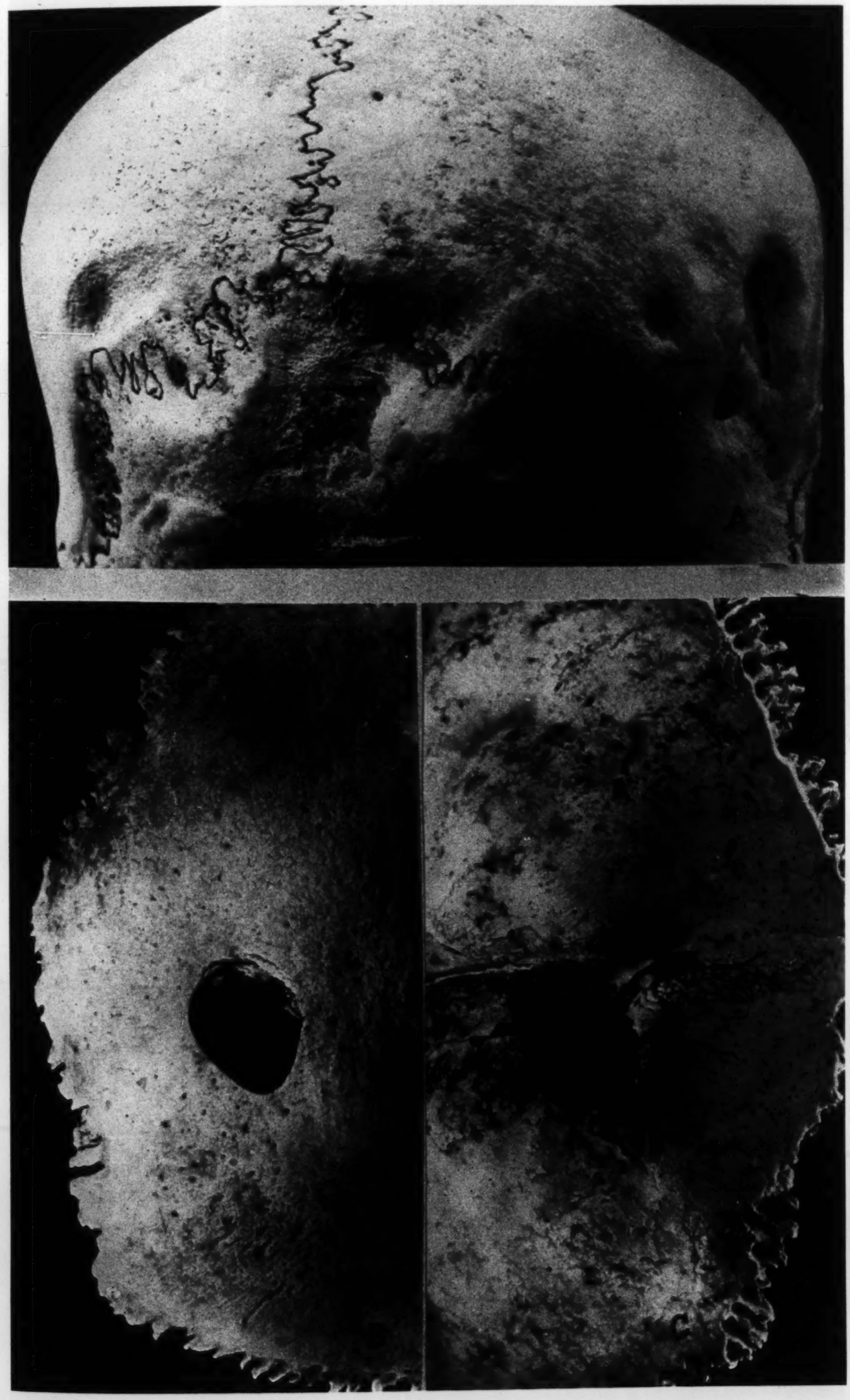


FIG. 21.

Peru. Female. Several old healed, perforating injuries in the right parietal.

No. 85. Prehistoric skull from Ancon, Peru. Male. Extensive old scar over the frontal and anterior parts of both parietals.

No. 86. Prehistoric skull from Chavina, Peru. Extensive lesions of the right and partly, also, of the left, with perforations into the antrum.

This is possibly an example of surgical interference to arrest the progress of the destructive disease known as Uta.

No. 87. Prehistoric skull from Cinco Cerros, Peru. Male. Old circular scar in the right frontoparietal region, possibly trepanation.

No. 89. Prehistoric, or early historic, skull from Conventillo, near mouth of Acari River, Peru. Male. Large old scar over right parietal.

No. 91. Part of prehistoric skull from Chicama Peru. Male. Two superficial scars, possibly due to some pathological process affecting the skin over these localities, on the posterior part of the parietals.

No. 92. Prehistoric skull from near Station Lucia, S. E., of Nasca, Peru. Male. Artificial deformation (Aymara variety). Old healed injuries on the left orbit and various parts of the face. Superficial.

It is a curiously interesting fact that skulls exhibiting the Aymara deformation seldom show lesions.

No. 93. Prehistoric skull from San Damian, Peru. Female. Old scar on the right parietal.

No. 94. Part of prehistoric skull from Lomas, Peru. Old perforation of the alveolar process, possibly traumatic.

No. 96. Part of a prehistoric skull from Chicama, Peru. A lesion perforating the external table of the skull in the frontal, above the left angular process.

No. 97. Part of a prehistoric skull from Coyungo, Peru. A lesion doubtless due to old injury of frontal.

No. 98. Part of a prehistoric skull from Nasca Region, Peru. Surface scar, possibly of traumatic origin: may be due to surgical abrasion of the surface.

No. 124. Part of prehistoric skull from Matucana, Peru. Male. Large injury by mace or club in the posterior part of vault.

No. 125. Prehistoric skull from Cinco Cerros. Peru. Male. Strongly developed. Large depressed healed injury, probably by a club, of the frontal and parietal.

No. 126. Prehistoric skull from Chilca, Peru. Male, Old depressed wound in the left part of the frontal, with radiating fracture to the right orbit. Old perforating wound to posterior part of the left parietal.

No. 130. Part of prehistoric skull from Nasca Region, Peru. Female. Extensive old injury in the right parietal with a fracture running down to the zygoma. Possibly trepanation about upper part of wound.

A moderate sized oval opening, 42 mm. in long diameter, at the upper, parietal end of an oblique, well-healed fracture of the right side (100 mm. long), possibly indicates a definite relation between a skull fracture and trephining, I can only say that the opening is *apparently* a trephine hole. The opening has well-healed but beveled edges (15 mm. wide) which recall the edges of certain trephine wounds, but there are no definite indications of tool marks, and the lesion may be a part of the fracture. This is a probable explanation because of slight corrugations seen on the inner table, which seem to have the same degree of development as the outer surface, recalling newly formed bone. The trephining may have been done shortly after the injury. There are no evidences of infection, externally or internally. The skull is thick and strong; maxilla edentulous.

The skull is cut sagittally and the other half is catalogued as No. 134.

No. 131. Part of prehistoric skull from Cinco Cerros, Peru. Female. Injury, with probable trephining, and subsequent healing in middle of frontal.

The lesion on this skull suggests a relation between injury and surgical interference, but is not clear enough to give definite proof. In fact I fail to find any definite sign of fracture at all, and the injury was probably a small depressed fractured area which had been removed by the operation. Around the area from which the bone is most deeply eroded, there is a slight elevation of bone, as if there had been an infection.

No. 235. Prehistoric skull from Cinco Cerros, Peru. Male. Old healed injury in the left temporoparietal region.

No. 236. Prehistoric skull from Pachacamac, Peru. Male. Old perforating healed injury to occipital.

No. 245. Part of prehistoric skull from Chavina, Peru. A round, perforating, healed wound, possibly due to a cylindrical arrow point, in the left parietal.

Arrow-point injuries are very rare among the remains of the pre-Columbian Peruvians so far studied. This fact indicates that the bow and arrow did not enter so largely into the affairs of these people as it did among the North American Indians.

No. 247. Portion of prehistoric right parietal from Chavina, Peru, showing a neat perforation, like a drill-hole, but evidently made in life and healed. Possibly the result of a wound by a cylindrical arrow point.

No. 248. Part of prehistoric skull from Nasca Region, Peru. A circular, perforating healed injury on the occipital.

No. 249. Part of prehistoric skull from Ancon, Peru. Female, aged. Old healed perforating injury in the right parietal.

No. 250. Part of prehistoric skull from San Damian, Peru. Female. Old healed injury with possibly a trephining in the frontal.

No. 254. Prehistoric skull from Cinco Cerros, Peru. Male. Ancient injury above both orbits, followed by trepanation (healed trephine opening measures 30 mm. × 50 mm.) with advanced healing. Another small trephining seemingly attempted at bregma.

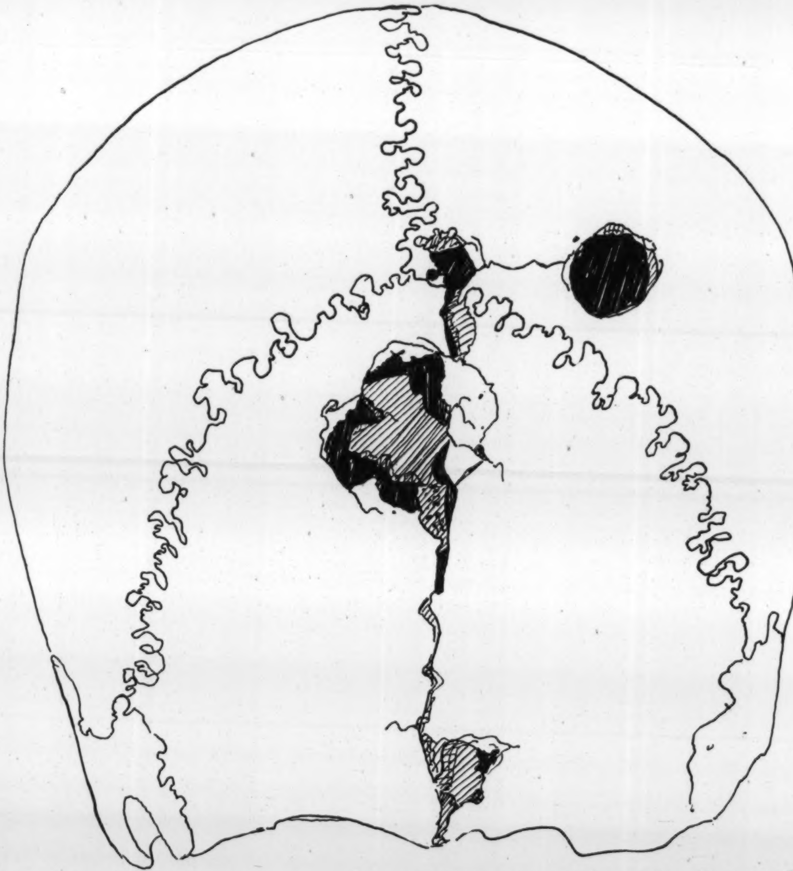


FIG. 22. SKULL NO. 16, SHOWING EXTENSIVE FRACTURE OF VAULT. THE CONTINUATION OF THIS FRACTURE IS SHOWN IN FIGURE 12c WHERE IT IS TERMINATED IN A DEFECT POSTERIOR TO THE FORAMEN MAGNUM. THE LONGEST FRACTURE LINE IN THE COLLECTION, AND DOUBTLESS FATAL.

This skull will be fully described and illustrated in a subsequent paper. It shows beyond any question a definite relation between injury and trephining. No. 257 shows a similar relation and will be fully dealt with later.

No. 266. Prehistoric, or early historic, skull from Conventillo, Peru. Female. Extensive old healed injury in the left parietal.

No. 283. Prehistoric skull from Matucana, Peru. Female. Fracture of the vault, following in part the coronal suture. Attempted trephining by the very rare method of drilling (See Fig. 19*b*). Very valuable specimen.

This skull will be fully dealt with in the paper on Surgery in pre-Columbian Peru.

No. 284. Prehistoric skull from Huarochiri, Peru. Male. Injury to the vault, with radiating fractures, followed by a double trepanation, one in each parietal, partly by cutting and partly by scraping. Some healing noticeable. Valuable specimen.

No. 291. Perhistoric skull from Lomas, Peru. Extensive, open, and thoroughly healed injury, with radiating fractures, on left parietal and occipital.

No. 299. Prehistoric skull from Cinco Cerros, Peru. Male. Injury with subsequent trephining, not completed, in the occipital. Extensive ancient injury on the left side of face (Fig. 19*c*).

No. 301. Prehistoric skull from Coyungo, Peru. Male. Old healed injury of left malar bone and in the posterior part of right parietal.

No. 322. Prehistoric skull from Pachacamac, Peru. Female. Old, healed perforating wound of frontal, possibly due to sling shot.

No. 323. Prehistoric skull from Pachacamac, Peru. Female. Depressed healed injury of the frontal.

Nos. 651, 652, 653, 654, 655, list a club, a sling and pebble, a star-shaped mace-head, a copper mace-axe, which are described and figured herewith: Figures 5 and 6.

No. 656. Prehistoric skull from a cave near Station Lucia, Peru. Female. Moderate Aymara deformation. Smashing wound of the upper and outer part of the right orbit. Another wound on the left parietal, with radiating fractures to coronal suture and over the lower part of both parietal bones: this wound shows signs of healing.

No. 657. Prehistoric skull from near Ica, Peru. Male. A circular, perforating, healed injury in the posterosuperior angle of the right parietal.

No. 658. Prehistoric skull from Lomas, Peru. Male. Skull surrounded by ancient bandage, applied in all probability for either surgical or other curative purpose. Unique specimen.[1]

No. 660. Prehistoric skull from Pachacamac, Peru. Old healed injuries of right side of face, particularly the malar.

No. 661. Part of prehistoric skull from Lomas, Peru. Male. Old injuries to right malar, angular process of frontal and outer wall of right orbit.

No. 662. Part of prehistoric skull from Chavina, Peru. Male. Old fracture of left malar.

No. 664. Prehistoric right malar bone. Old fracture.

No. 665. Portion of prehistoric skull from Chavina, Peru. Male. Old fracture of left malar.

No. 666. Part of prehistoric skull from Lomas, Peru. Male. Old injury of left malar.

## Résumé

An examination of the 119 skulls in the San Diego Museum exhibiting injuries shows that the nature of the injury may very often be definitely determined, as to the nature of the weapon producing the lesion, whether sling shot, club, mace-axe, or arrow point. The nature of the depressed fractured area is often so circumscribed that the entire area would be completely removed by trephining.

The male skulls showing injuries are only slightly in excess of the female, indicating an entire lack of chivalrous regard for women.

These ancient Indians had only a slight notion of the hospital care of the wounded, or none at all. Indications of relief measures are meager.

Infections were infrequent, and recovery often from severely infected wounds was common. Most of the injuries healed without infection. Healing was often rapid.

A careful study of the collection shows a few skulls which exhibit definite relations between fractures, or other injuries or disease, and trephining. It is shown that trephining was developed in response to sling shot injuries. The prevalent use of the sling shot as a weapon may account for the immense number of trephined skulls known from ancient Peru.

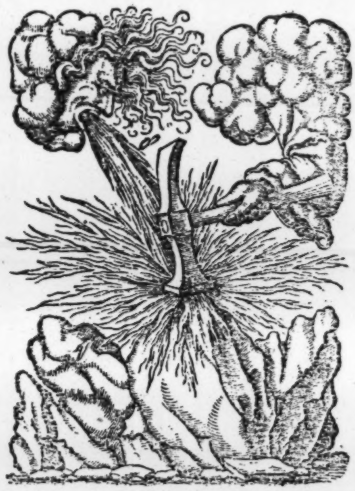
Following papers will discuss more carefully the nature of the surgical procedures and surgical instruments; the relation of disease to surgical interference and the nature of fractures and dislocations of the limb bones.

---

[1] Described in Studies in Paleopathology, xiv. A prehistoric surgical Bandage from Peru. Annals of Medical History, viii, No. 1, pp. 69–72; 4 figures.

## REFERENCES

1. Singer, C. The Evolution of Anatomy. N. Y., 1925, p. 13.
2. Cushing, H. A study of a series of wounds involving the brain and its enveloping structures. *Brit. J. Surg.*, 1918, v, 558–684, Figs. 459–683.
3. Moodie, R. L. Studies in paleopathology, xviii. Tumors of the head among pre-Columbian Peruvians. Ann. M. Hist., 1926, viii, 394–412, Figs. 1–15.
4. Means, P. A. Distribution and use of slings in pre-Columbian America, with descriptive catalogue of ancient Peruvian slings in the United States National Museum. *Proc. U. S. Nat. Mus.*, 1919, lv, 317–349, Pls. 22–27.
5. Reiss, W., and Stübel, A. The Necropolis of Ancon in Peru. A Contribution to our Knowledge of the Culture and Industries of the Empire of the Incas, being the Results of Excavations made on the Spot. Trans. by Prof. A. H. Keane. 3 vols. Berl., 1880–1887.
6. Moodie, R. L. A variant of the sincipital T from Peru. *Am. J. Phys. Anthrop.*, Wash., 1921, iv, No. 2, 219–222. 2 Pls.
7. Keith, A. Bones showing effects of gun-shot injuries. *Brit. J. Surg.*, 1919, vi, 537.
   Specimens of long bones showing the processes of infection and repair. *Ibid.*, vii, 302–319, Figs. 272–300.
8. Hilton-Simpson, M. W. Arab Medicine and Surgery. A Study of the Healing Art in Algeria. Lond., 1922.



[Franciscus Vallesius Hippocrates, Coloniae, 1589.]

[From Crooke: A Description of the Body of Man. London, 1631.]

# EDITORIAL

Apropos of the splendid tributes which have been paid to the memory of Lord Lister in connection with the centenary of his birth, the history of the surgical ward in which he carried on his researches and first proved the value of his methods is of great interest. Lister worked in this ward from the time he went to Glasgow in 1860 until his return to Edinburg as Syme's successor in 1869. Among the great mass of Listeriana which has appeared, one of the most remarkable contributions is a book[1] in which the vicissitudes of his ward and its seemingly wanton destruction are set forth at length. This is a most remarkable contribution to the literature bearing upon Lister's life and work. It is a bitter, but one cannot help feeling a justifiable, arraignment of the Board of Managers of the Royal Infirmary of Glasgow for their apparently wanton destruction of the Ward in which Lister, over a series of years, carried on the clinical investigations which resulted in establishing the truth of his ideas on the cause of infection in wounds. Within its walls Lister himself treated many patients and these fortunate sufferers not only benefited themselves by the application of his discovery but through them its efficacy was demonstrated to the world at large.

Lister died in 1912 and his death was the occasion of a great outburst of praise and appreciation from all quarters of the globe. Sometime after a committee was appointed to consider what steps should be taken in Glasgow to commemorate his work there. A suggestion which met with universal approval was that his Ward at the Royal Infirmary should be preserved and used as a Lister museum. The committee received most generous subscriptions to a fund for this purpose and all seemed going well when they were astounded to learn that the Managers of the Infirmary had determined to destroy the Ward. This was in 1923 and this resolution was shortly put into effect, despite protests and appeals from scientific bodies and medical men the world over, including the French Academy and the leading medical societies of the United States. One citizen of Glasgow offered to donate the sum of two thousands pounds towards the cost of the structural alterations required to preserve the Ward. To all pleas, protests and offers of money the Board of Managers of the Infirmary turned a deaf ear, and the Ward was demolished.

Up to the present time nothing has been done to replace the Ward and this book contains a picture of the unsightly ruins of the basement as they remain January, 1927. Were those who were responsible for the devastation accomplished in 1923 to visit the Wellcome Museum and witness the interest excited by this exhibition, we wonder whether some feelings of regret would not arise within them for the priceless treasure they had cast away. An American hospital exhibits with pride in the wall of one of its surgical wards a memorial plaque to Lister, framed in bricks taken from the ruined walls of the original Ward. One wonders what can have prompted such an act on the part of the Managers. The excuses they offered seem very weak, to wit, that the Ward was septic, that a new and better one was to be built, and that it cut off light and air from another ward. The old Ward was used during the World

---

[1] Lister and the Lister Ward in the Royal Infirmary of Glasgow. A Centenary Contribution, Glasgow, Jackson, Wylie & Co., 1927.

War for wounded soldiers and no evidence of any unsanitary conditions occurred; no attempt has been made to build a new ward in its place, and according to the plans shown in this book it did not interfere with the light or air of any other structure. It must naturally have been a repugnant task to the compilers of this book to wash the dirty linen of a famous old institution in public. On the other hand now that the Wellcome Museum has shown how Lister's workroom is held in veneration as a shrine, it is not to be wondered at that those who earnestly worked to preserve the invaluable relic where it belonged should feel that in justice to themselves the world should be told the truth and the responsibility for such an unheard of proceeding laid where it belonged. To the uninitiated it would seem as though the Board of Trustees of the Royal Infirmary in the year of 1923 acted on some basis of personal animosity directed against the memory of the greatest man who ever served their institution.

If the Managers of the Glasgow Royal Infirmary showed such a lamentable disregard of their great opportunity others were more appreciative and realized what the preservation of any relics of such a great man's work would mean to future generations. The authorities of the Wellcome Historical Medical Museum in London opened a Lister Centenary Exhibition at the Museum which has excited the greatest attention and won the unstinted admiration of visitors from all over the world. They have issued a beautiful little handbook describing the many objects illustrating Lister's activities which were exhibited and most of which are permanently lodged in the Museum. The most striking exhibit was a section of Lister's Ward at the Glasgow Royal Infirmary, fitted up with furniture, apparatus, etc. which had either actually been used in it or were exact reproductions. It is one of the most impressive shrines that one can visit. Standing within it one can visualize the great surgeon at his work and recall the struggles through which he passed to the completion of his task. The collection of other relics is too long for an attempt at enumeration. Many portraits, busts, pictures of his various homes and places connected with his career are also shown, and many of his notebooks and manuscripts. The catalogue of the collection is a valuable addition to any library of medical history. Its worth is much enhanced by the Introduction written by Sir Hector Cameron, formerly Lister's associate, and by a short life of Lister with chapters on his work, and lists of his associates at the different hospitals in which he worked. An excellent bibliography of Lister's own writings and of books and articles on him is appended. The Wellcome Historical Medical Museum has made splendid amends for the neglect of the former Managers of the Glasgow Royal Infirmary.

FRANCIS R. PACKARD.

[Les Sonnets du Docteur.]

# BOOK REVIEWS

Lister as I Knew Him. By John Rudd Leeson, M.D. William Wood & Co., N. Y., 1927.

This book differs from and is a most valuable supplement to the formal biographies of Lister, such as those written by Godlee and Wrench. It contains the personal recollections of one who was thrown in intimate contact with Lister at the most interesting period of his career, during the years when he was achieving the first proofs of the correctness of his ideas and beginning to convince the world of their importance.

In 1871 Dr. Leeson began his medical career as a student at St. Thomas' Hospital in London. The Hospital, the newest in London, having been opened by Queen Victoria in the same year was the first to be built on the pavilion plan, and, as a new building, on a new site, with the very latest views on proper hospital construction employed in its erection, and above all having a staff of trained nurses, Miss Nightingale having selected St. Thomas' as the headquarters for her training school, it was hoped would escape the terrible blight of "hospitalism," the septic diseases which were so rife in all the hospitals of the day. Leeson gives a sad and vivid picture of the way in which a short time, pyemia, septicemia and erysipelas, prevailed within its walls, just as much as in the other older hospitals. When he narrates how the surgeons operated in frockcoats which had been worn and soiled by previous use in the dissecting room, used leather pocket-cases lined with velvet plush begrimed with blood and pus, and in dressing their cases used a "ward sponge" which was simply wrung out in warm water between its use on one case after another we grasp the reason for the prevalence of septic diseases in the surgical wards. The surgeons of the day, however, did not.

One day Dr. Charles Murchison, the great authority of his time on fevers, said to Leeson: "If I were you, Mr. Leeson, I should not spend the whole of my time at St. Thomas', I should go to Edinburgh and follow the practice of Professor Lister; I believe there is a great future before his work and that it is well worth your while to study it." This was unusual advice but fortunately Leeson followed it and armed with a letter from Murchison to Lister went to Edinburgh, and shortly afterwards was appointed one of Lister's dressers. He contrasts the difference in the condition of the patients in Lister's charge with that of those whom he had seen in the wards of the wonderful new hospital he had just left. Although the old ward was dark, gloomy and crowded, the patients all seemed happy and comfortable. The temperature charts at the head of the beds seemed to show a strangely even row of dots almost along the normal and as he saw no trained nurses he thought that they must be unreliable. Then he describes the meticulous care with which Lister performed every dressing and how careful he was not only in the use of his carbolic spray and solutions but in the application of his gauze, bandages and splints. Leeson was fascinated by Lister's personality and his initimate description of his master's characteristics brings him more vividly before us than any other that we have read. Although Lister was the most kind-hearted and amiable of men there was an atmosphere of aloofness about him which seems to have overawed all those who assisted him at any time in his career. For one thing Lister was very formal in his manner. He invariably addressed his clerks and dressers as "Mr. so-and-so," never calling them by their names in any of the students' merrymakings in which some of the Edinburgh professors seem to have mingled quite frequently in his day. Of course, Lister always wore the traditional professional garb of the day, a high hat and long frockcoat, and his tall and dignified presence must have been awe-inspiring. Leeson draws a pleasing pen picture of Lister's personal appearance and quotes Henley's well-known poem describing it. Although crowds of students and many foreign surgeons thronged Lister's wards and followed with breathless interest the methods he employed, his colleagues on the staff stood aloof. They never visited his ward nor asked him to see a case in consultation. The junior staff did not share this disdainful attitude. Drs. Miller and Bishop, assistant surgeons to the Infirmary, and Dr. John Chienne, became enthusiastic converts. Lister's own attitude towards his colleagues was marked by his usual modesty and courtesy. He never spoke of them and they apparently played no part in his life, but there was one Edinburgh surgeon, Dr. Thomas Keith to whom he would always refer cases requiring ovariotomy saying, "Whilst there is in this city such a masterhand as that of Dr. Thomas Keith it would be criminal for me to operate." Lister was in the habit of exposing his occasional mistakes perfectly openly to his class and the foreign surgeons who attended his lectures. He was a wonderful teacher of the principles and practice of surgery but of little use to the student who had to prepare for examinations. He held examinations in contempt, never recommended any textbooks to his students, and never wrote a textbook himself, but he made the student's mind work at basic facts and impressed them on him in an incomparable manner. Leeson describes the technique employed by Lister and the variations he made in it as his investigations progressed. He gives comparatively small space to the experiments by which Lister established the truth of his views, but they are fully described in the larger biographies which are readily available. As a record of Lister's personality and his influence on those who worked with him, and of the difficulties he encountered this little book is unequalled. It is a most delightful and important contribution to Listeriana.

FRANCIS R. PACKARD.

DIE LEHRE VON DER HEILKRAFT DER NATUR IM WANDEL DER ZEITEN. (The Doctrine of the Healing Power of Nature through the Ages.) By Dr. med. et phil. Max Neuburger. Stuttgart Enke, 1926.

Professor Neuburger in the volume under review, has set himself the fascinating problem of tracing the evolution of the belief in the healing power of Nature, the *Vis Medicatrix Naturae*, which tends to cure disease without the aid of physic. After a brief introduction in which the subject is attractively outlined, the text follows and is divided into four parts. The first deals with the beliefs of ancient and Renaissance writers, the second with those of the sixteenth and seventeenth centuries, the third with the eighteenth century, and the fourth with the first half of the nineteenth.

The writer emphasizes that the gradual recognition of the healing power of nature has been one of the most powerful influences in the history of medical thought. It is the antidote of the ignorant polypharmacy, so rife in the sixteenth and seventeenth centuries, which still lurks among the best of us at the present day, and its perennial "rediscovery" by half-educated minds is largely responsible for the ubiquitous cult of faith-healing. Recognition of the extent and limitations of the healing power of nature by the laity would do much to stamp out the quack and the charlatan. Consequently the present volume is one which should appeal to a wide range of readers, lay and medical, and to anyone of historical tastes.

An attractive feature of Professor Neuburger's book is the copious use which he has made of quotations from original sources. In reading of the seventeenth and eighteenth century writers, one is surprised and pleased to discover the large part taken by Englishmen in spreading the gospel of natural healing. Professor Neuburger has reproduced (p. 73) a title-page of Gideon Harvey's "The Art of Curing Diseases by Expectation" (London, 1689), a highly influential work which reminded the practitioners of its day that an attitude of *laissez faire* was frequently the wisest policy. Liberal quotations are also given from Robert Boyle ("A Free Inquiry into the Vulgarly Received Notions of Nature," London, 1686), the omnicient English physicist whose three hundredth anniversary falls this year. Boyle urged that the wise physician studied Nature's remedies, assisting them when ineffective, and checking them when too violent. Boyle says (p. 227, 1866, ed.):

> And therefore physicians do oftentimes very well, when, to act agreeably to the dictates of prudence, they forget how much wisdom they are wont to ascribe to nature, and employ their best skill and remedies to suppress or moderate the inordinate motions, or the improper and profuse evacuations, that irritated nature rashly begins to make.

Dr. Neuburger has not omitted to mention the work of Jacob Bigelow. He points out (p.

135) that Bigelow's "Discourse on Self-Limited Diseases," delivered before the Massachusetts Medical Society, May 7, 1835, exerted a great influence both in this country and abroad in stimulating rational therapeusis. The following remarkable passage is cited from Bigelow's work:

> The longer and the more philosophically we contemplate this subject, the more obvious it will appear, that the physician is but the minister and servant of nature; that in cases like those which have been engaging our consideration, we can do little more than follow in the train of disease, and endeavor to aid nature in her salutary intentions, or to remove obstacles out of her path. How little, indeed, could we accomplish without her aid! It has been wisely observed by Sir Gilbert Blane [Medical Logic, p. 49], that "the benefit derivable to mankind at large, from artificial remedies, is so limited, that if a spontaneous principle of restoration had not existed, the human species would long ago have been extinct."

Professor Neuburger's acquaintance with medical literature is enormous, and his intimate knowledge of even the most obscure English writers is truly astonishing. Those who have read his scholarly account of Bacon's "Relation to Medicine," written some months ago in *Medical Life* (N. Y., XXXIII, 150), will also have gained insight into the extent of his learning. The present volume can be recommended to all students of medicine who wish to gain adequate historical perspective in a field of thought which is probably second to none in importance to medical science.

J. F. FULTON.

IMHOTEP, THE VIZIER AND PHYSICIAN OF KING ZOSER AND AFTERWARDS THE EGYPTIAN GOD OF MEDICINE. By Jamieson B. Hurry, M.A., M.D. New York, Oxford University Press, 1926.

The wonderful discoveries made in the tombs of Egypt by archeologists in the last few years have filled up many lacunae in our knowledge of that most wonderful land of antiquities and have stimulated interest in its past in marvelous fashion. The name of "Dr. Imhotep" as Sir William Osler was wont to term him, has been familiar to all students of medical history as one of the worthies of Egyptian medicine, but definite knowledge of his life and character was mostly buried in books or writings of a strictly historical or archeological nature and accordingly not readily available to the ordinary reader. In this delightful little book Dr. Hurry gives all the details known of one who, again to quote Osler, was "The first Figure of a Physician to stand out clearly from the Mists of Antiquity."

Imhotep was the Vizier of King Zoser, who flourished from *circa* 2980 to 2900, B.C. He was also an architect under whose supervision was built the great Step-Pyramid of Sakkarah, near Memphis, still an object of interest to the traveler and the earliest large stone structure still standing. As Hurry states, this Step-Pyramid is an evidence of a high state of civilization; "There must have been wealth in the Pharaonic exchequer, stable government by the vizier and other officials, experience in the organization of labour, aptitude in the keeping of complex accounts, technical skill in the quarrying, dressing, and transportation of stone." Imhotep likewise was chief lector priest or *Kheri-heb*, a most important ecclesiastical position, and at the same time court physician. Both of these positions implied the possession of magical power by the holder, as religion and medicine were closely bound up with magic in ancient Egypt. Imhotep, according to records which have been transcribed, was also held in much esteem as an astronomer and his sayings were transmitted to posterity as those of a sage.

Of special interest to medical history is the manner by which this busy man of affairs, a sort of Richelieu of antiquity, became ranked first as a demi-god and then as a god of medicine. Hurry points out that both the Greeks and Romans were wont to recognize a sort of demi-god stage before the full apotheosis of the individual. Imhotep passed through such a period from some time after his death until the Persian conquest of Egypt about 525 B.C., when he was granted his full apotheosis. We know that his earthly father was Kanofer, in his time also a famous architect. After his apotheosis it was asserted that Imhotep was really the son of the god Ptah.

We now find the Greeks, who permeated Egypt, identifying him with Asklepios, their god of medicine, and thenceforth the two myths are united. Hurry points out the fact that this real man antedates the Greek mythical Aesculapius, and that it is high time that he should receive the honors of which he has been deprived in modern times. While there are innumerable tokens of homage to Aesculapius on the part of the profession in the form of societies and institutions named after him, symbols, medals and devices used in his honor, and statues erected in his supposed likeness, there are but few evidences of regard offered to the real god of medicine. Dr. Hurry points out that the Reading Pathological Society, the oldest of its kind in Great Britain, has recently adopted Imhotep as its badge: "This is probably the first recognition by a Medical Society of the claims of Imhotep to be recognized as the patron saint of the healing art."

There is a great deal of most valuable information in Dr. Hurry's book concerning the practice of medicine in Egypt. Delightfully written and beautifully illustrated it is a most original and valuable monograph on a very important and little known department of medical history.

FRANCIS R. PACKARD.

EARLY MEDICAL AND BIOLOGICAL SCIENCE, EXTRACTED FROM EARLY SCIENCE IN OXFORD. By R. T. Gunther, M.A., L.L.D., F.L.S., Fellow of Magdalen College. New York, Oxford University Press, 1926.

This book consists of the first 246 pages of the large volume entitled "The Biological Sciences and Collections" which constitutes volume III of Gunther's splendid large work on "Early Science at Oxford," and we cannot but feel that in thus republishing in cheaper form the most essential part of his *magnum opus* Dr. Gunther has made a considerable sacrifice. In this small volume will be found the most important historical data which throw so much light on the scientific activities of Oxford from the earliest times, through the wonderful period when Willis, Wren and other scientists worked there in the seventeenth century, down to the days of Buckland and his colleagues in the nineteenth century. For most readers the omission of the long lists of objects contained in the various biological collections at Oxford will not be a serious loss, whereas to every student of medical history the contents of the smaller work will afford an invaluable mine of hitherto largely ignored material. The importance of Dr. Gunther's labors in his chosen field can hardly be overestimated. It should be recalled that he has performed similar service not only to medical and biological science but that his work also covers the fields of physics, mathematics and astronomy. It would be well if other of the world's older scientific or learned bodies had similar sons who were capable of or willing to undertake such labors.

FRANCIS R. PACKARD.

HISTORY OF CARDIOLOGY. By Louis Faugères Bishof, M.C., M.D., and John Neilson, Jr. B.S., M.D. Introduction by Victor Robinson, PH.D., M.D. N. Y. Medical Life Press, 1927.

In this slender volume the history of the development of an accurate knowledge first of the anatomy and physiology of the circulation and later of its pathology, clinical manifestations in disease, and therapeutics, is told in a concise but comprehensive way. The Authors state in their preface "It is only by an historical approach that the true philosophy of any science can be appreciated," and their book is an excellent effort to afford such an approach to the science of cardiology. They first consider the "pre-scientific period" in which the ancients promulgated many theories concerning the heart and vessels most of which were purely fantastical, not being based on any substantial anatomic foundation. The second section is devoted to the "period of scientific investigation" and considers the labors of the men who laid the foundations of a correct knowledge of anatomy from Mondino to Harvey and the school of microscopists headed by Malpighi who found the evidence which furnished the missing links in the circulatory system. In this connection it is to be regretted that there is no mention made of the great work done by van Leeuwenhoek, although reference is made to it by Dr. Robinson in his introduction to the book. Aside from this omission this section is adequte to the importance of the subject. The last portion of the book deals with the "period of scientific application" and is thoroughly well done, concluding with a consideration of the work of Schott, Groedel, and Sir James Mackenzie. It certainly deserves the appreciation of all cardiologists as an excellent concise summary of the modern science of cardiology.

In so condensed a work it is not quite fair to notice omissions but we regret that a more than passing reference could not be made to the work of the Alexandrian School as exemplified by Erasistratus and Herophilus. It is well known that the pulsus caprisans, or dicrotic pulse, was so named by Herophilus, who devoted much time to a study of the variations in the pulse. In mentioning Sylvius the statement is made that "It is also believed he knew that valves existed in the veins." Cushing and Streeter have recently published a facsimile edition of Canano's work on the muscles and in the biographical notice which accompanies it Streeter tells the complete story of the discovery of these valves by that most able anatomist. Sylvius knew of them only by hearsay. It is open to doubt whether he ever actually observed them by dissection.

While the history of many of the more strictly defined specialties such as laryngology, ophthalmology, etc. have been adequately treated in historical monographs this book is somewhat of a novelty and one which it is to be hoped will incite to further efforts in a like direction in other branches of internal medicine. The Authors have made a successful effort to illustrate the value of a good historical perspective in the study of clinical conditions. The book contains many interesting and well-chosen illustrations.

Frances R. Packard.

[From Erastus: Varia Opusculum Medica. Frankfurt. a.M., 1590.]

# ANNALS OF MEDICAL HISTORY

*Editor:* FRANCIS R. PACKARD, M.D., Philadelphia

---

## CONTENTS OF VOLUME FIVE

Brown, Anatomical Habitat of the Soul; Viets, Eponymic History of the Ganglion Semilunare (Gasseri); Dobley, Riolan and Harvey; Middleton, William Edmonds Horner; Fisher, Incunabula Library of the College of Physicians; Sands, Review of an Early Paper on Malaria; Maxwell, "Ta Sheng P'ien," a Chinese Household Manual of Obstetrics; Middleton, Joseph Leidy; Kerr and Pleadwell, Lewis Heermann; Lloyd, Dr. John Mennis and His Title; Cumston, Overlooked Painting of Saint Roche; Charlton, Medicine in Lower Canada; Crummer, Anatomical Fugitive Sheets; Bailey, William Hewson; Packard, Earlier Methods in the Treatment of Syphilis; Villegas, Primitive Medicine in the Philippines; Riddell, Hydrophobia: Four Centuries Ago; Mendelson, Maimonides; Riesman, A Physician in the Papal Chair; Rochester, Richard Bright; Gwyn, Osler, Student of the Toronto School of Medicine; Courtney, Molière and the Faculty; Pleadwell, Edward Cutbush; Elkin, Transylvania School and Oliver Perry Hill; Kobro, Three Medical Pioneers in Norway.

## CONTENTS OF VOLUME SIX

Courtney, The Multiple Personality of Patin; Larsell, Anders Adolf Retzius; Brown, De Venenis of Petrus Abbonus; Ballard, Outline of the History of Medicine from Its Earliest Days to 600 B.C.; Stimson, Conflict of Medicine with Quackery; Kerr, Elisha Kent Kane; Coriat, Symbolism of the Gold-Headed Cane; Incunabula: Library of the Medical Society of the County of Kings, Brooklyn; Library of the Pennsylvania Hospital, Philadelphia; Library of the School of Medicine of Washington University, St. Louis; Chance, Sir William Bowman; John, Surgical Clinic of Charles University, Prague, 100 Years Ago; Morrison, Carl Weigert; Burget, Lazzaro Spallanzani; Toomey, Sir William Buttes, Physician of Henry VIII Mentioned by Shakespeare; Ruhräh, James Atkinson and His Medical Bibliography; Charlton, Medicine in Lower Canada; Pleadwell, Elisha North and His Treatise on Spotted Fever; Dawson, Semmelweis; Davis, Neglected Evidence in the History of Phlogiston, Observations on the Doctrine of Forms and History of Alchemy; Moschcowitz, Unpublished Letter of Sir Thomas Browne; Chavarria and Shipley, First Known Post-Mortem Examination in the New World; Courtney, Gabriel Naude; Moschcowitz, First Editions of Sir Thomas Browne; Bast, Samuel Thomas von Sömmerring; Kerr, William Maxwell Wood; Middleton, Biographic History of Physical Diagnosis; Van Andel, Ceraunia or Thunder Axe; Coriat, Rabelais the Physician; Cumston, Notes on Smallpox and Inoculation; Robertson, "The Breviarie of Health" by Andrew Boorde; Dana, The Seguins of New York.

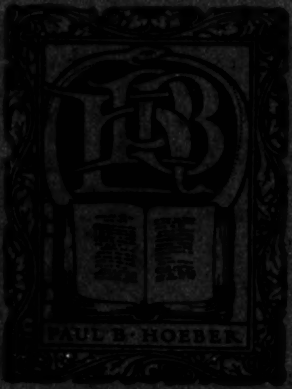
## CONTENTS OF VOLUME SEVEN

Crummer, Anatomical Fugitive Sheets; Miller, James Mease; Danker, Doctor Smollett; Goodman, Master Dermatologists; Dawson, Su Wen, the Basis of Chinese Medicine; Ruhräh, William Cadogan; Chen, Chinese Drug Stores; Burget, Stephen Hales; Wright, Medical Essay on the Timaeus; Kobro, Gerhard Henrik Armauer Hansen; Krumbhaar, Experimental Cancer; Bragman, Maimonides on "Physical Hygiene"; Hall, Samuel Thomson; Packard, Selections from Gibson's "Rambles in Europe"; [illegible], Thomas Sydenham; Randall, Curiosities from the Collection of Calculi; Rolleston, Caleb Hillier Parry; Robertson, Digby's Receipts; D'Irsay, Black Death and the Medieval Universities; Allyn, Black Death; Gibson, Thomas Dent Mutter; Hayman, Malpighi's "Concerning the Structure of the Kidneys"; Ball, Ether Tragedies; Taylor, Crawford Williamson Long; Hume, Pettenkofer's Theory of the Etiology of Cholera; Williamson, Sir Dominic Corrigan; D'Irsay, Gilles de Corbeil; Menne, Carl Rokitansky; Robertson, Powder of Sympathy; Bragman, Medical Wisdom of Mark Twain; Garrison, Poem in Praise of Ophthalmologists.

## CONTENTS OF VOLUME EIGHT

Rolleston, Poetry and Physic; Read, Old Chinese Medicine; Howell, Workers in the Cause of Anatomy 100 Years Ago; Eloesser, Pirate and Buccaneer Doctors; Malloch, Galen; Moodie, Studies in Paleopathology XIV-XIX; Bast, Adolf Kussmaul; Garrison, Medical Numismatics; Gibbon, Samuel D. Gross; Diller, Pioneer Medicine in Western Pennsylvania; Howell, Some Old Medical Journals; Walsh, Galen and the Recurrent Laryngeal Nerve; Chen and Ling, Chinese Medical History; Min, China's Contribution to Medicine in the Past; Middleton, John Redman; Beck, Operative Story of the Heart; D'Irsay, Teachers and Textbooks in the Medieval University of Paris; Robertson, Unicorn's Horn, Coral and Stones; Owen, Poore's Plague and Pepys; Lloyd, De Mandeville and His Fable of the Bees; Chance, Sir William Lawrence; Cumston, Herpes; Rolleston, Worthies of the Cambridge Medical School; Cole, Francesco Redi; Krumbhaar, Medals and Tokens; Fox, Microscopical Preparations from Original Tissue Described by Hodgkin; Miller, Abraham Chovet; Wile, Asklepios, the Tholos and the Theater; Wood, Ayurvedic Medicine in Ceylon.

Published by PAUL B. HOEBER, Inc., 76 FIFTH AVENUE, NEW YORK, N.Y.


PB
PAUL B. HOEBER

OLUME IX, NO. 4

1927

DECEMBER

# ANNALS OF MEDICAL HISTORY

VANDERBILT UNIVERSITY
LIBRARY
JAN 2 193
SCHOOL OF MEDICINE

FRANCIS R. PACKARD. M.D. EDITOR [PHILADELPHIA]
PUBLISHED QUARTERLY BY PAUL B. HOEBER, INC.
SEVENTY-SIX FIFTH AVENUE. NEW YORK. N.Y.

Entered as second class matter June 2, 1917, at the post office at New York, N. Y., under the Act of March 3, 1879.
Yearly Subscription, $8.00. Single numbers, $2.50.

# ANNALS OF MEDICAL HISTORY

*Editor*: FRANCIS R. PACKARD, M.D., Philadelphia

---

## CONTENTS OF VOLUME ONE

Singer, Girolamo Fracastoro; Garrison, Greek Cult of the Dead and Chthonian Deities; Cordus, Three Characters of a Physician; Bailey, Voltaire's Relation to Medicine; Streeter, Unpublished Bronze Écorché; Burr, Burke and Hare, the Psychology of Murder; Spivak, Hebrew Prayers for the Sick; Friedberg, Colonial Laryngology and Otology; Jacobi, Eulogy of Dr. John Shaw Billings; Sudhoff, The Hygienic Idea in World History; Viets, Patronal Festival for Thomas Willis with Remarks by Osler; Smith, Medicine and Mathematics in the 16th Century; Roy, Development of Our Knowledge of the Circulation; Allemann, Jetons of the Old Paris Academy; Klebs, History of Infection; Shippen's Draft of a Plan for the Military Hospital; Bowen, Beginnings of Intravenous Medication; Owen, Legislative and Administrative History of the Medical Department of the U. S. Army; DeVoynich and Garrison, Skeletal and Visceral Anatomy in the Book of Hours; Jastrow, Babylonian-Assyrian Medicine; Singer, Greek Charm Used in England in the 12th Century; Heizmann, Military Sanitation in the 16th-18th Centuries; Medical Incunabula: Surgeon-General's Library; Osler, First Printed Documents Relating to America; Singer, Byzantine Medical Fragments; Jacobi, N. Y. Medical College; Moodie, Studies in Paleopathology; Singer and Levy, Plague Tractates; Royster, Medical Phrases of Victor Hugo.

## CONTENTS OF VOLUME TWO

Corner, Anatomists in Search of the Soul; Jayne, Medical Gods of Iran; Warren, "Pulmotor" of the 18th Century; McCulloch, Compiegne; Garrison, Birthplace of the Hunters; Walsh, Laryngology and Rhinology; McCulloch, Chasseurs D'Alpin; Wright, Modern Commentaries on Hippocrates; McCulloch, L'Ambulanteuse; Fisher, Incunabula: Library of the College of Physicians, Phila.; Thomson, House-Surgeon's Memories of Lister; Power, Oxford Physic Garden; Riesman, Rise and History of Clinical Teaching; Fite, Napoleon's Camp at Boulogne; Cushing, Osler, the Man; Kelly, Osler, a Tribute; Ruhräh, Osler's Influence on Medical Libraries in the U. S.; Yonge, Ariphron's Hymn to Health; Garrison, Osler's Contributions to Medical Literature; Presentation to Sir William Osler on the Occasion of the 70th Anniversary of His Birthday at Oxford; Foote, Ancient Poems of Infant Hygiene; Ruhräh, Walter Harris; Moodie, New Observations in Paleopathology; Burr, Jean Paul Marat; Stokes, Graves at Sea; Rosenbloom, Appreciation of Henry Bence Jones; Cumston, The [illegible] of Felix Platter; Pleadwell, William Paul Crillon Barton; [illegible], Death of Robert Levet; Garrison and Streeter, Sculpture and Painting as Modes of Anatomical Illustration; Montgomery, The Quintessence in Rabelais; Ruhräh, Thomas Phaer; Rosenbloom, Statements of Medical Interest from the Life of Cellini; Lamb, Daniel Turner and the First Degree of M.D. Conferred in the English Colonies of North America; Abbatt, Isaac Senter; Harris, Latin Translation of Galen by Andres Laguna, with Notes, Dedication, Life of Galen, Index.

## CONTENTS OF VOLUME THREE

Warren, Collection of the Boston Phrenological Society; Coriat, Ancient Egyptian Prescription for Hysteria; Jacobs, Elizabeth Fry, Pastor Fliedner and Florence Nightingale; Hemmeter, Da Vinci as a Scientist; Webb, Sir William Osler; Griffiths, Shakespere and Medicine; Podolsky, Assyro-Babylonian Treatise on Diseases of the Male Urinary and Genital Organs; Friedenwald, Giving of Medical Degrees in the Middle Ages by Other than Academic Authority; Skavlem, Thomas Bartholin; Taylor, Montaigne and Medicine; Dana, A Great Consultation, Cardan Goes to Edinburgh; Lines to a Skeleton; Singer, Unrecognized Anglo-Saxon Medical Text; Wood, First Scientific Work on Spectacles; Middleton, Charles Caldwell; Kelly, Lafayette Houghton Bunnell, Discoverer of the Yosemite; Colwell, Gideon Harvey. Medical Life from the Restoration to the End of the 17th Century; Donley, Last Illness and Post-Mortem Examination of Malpighi; Brown, Christian Science Cure in the 16th Century; Cumston, Treatment of Trachoma, with Reference to the Arabian School and Ali Ibn-El-Aissa; Ruhräh, John Shaw; Charlton, William Rawlins Beaumont; Cowdry, [illegible] Ideas of Anatomy; Sayle, Library of Thomas Lorkyn; Gunther, Books of Nicholas Gibbard; Ruhräh, John Ferriar; Gruner, Interpretation of Avicenna; Harris, Emerods, Mice and the Plague of I Samuel; Turrell, Three Electrotherapists of the 18th Century: Wesley, Marat and Graham; Cumston, Treatment of Surgical Affections of the Lachrymal Apparatus; Wright, Forerunners of Empedocles and the Nature Philosophers; Rosenbloom, Thomas Hodgkin and Sir Moses Montefiore; Abbatt, Erasmus Darwin, "Zoonomia"; Middleton, The John Kearsleys; Coriat, Psychology of Medical Satire.

## CONTENTS OF VOLUME FOUR

Faber, Nosography in Modern Internal Medicine; Middleton, Caspar Wistar, Jr.; Da Costa, French School of Surgery in the Reign of Louis Philippe; Gibbon, London Surgery in the Early 19th Century; Riesman, Dublin Medical School, Its Influence on Medicine in America; Rosenbloom, History of Pulse Timing; John Floyer and His Physician's Pulse Watch; Viets, De Staticis Experimentis of Nicolaus Cusanus; Packard, Guy Patin and the Medical Profession in Paris in the 17th Century; Wood, Louis Daniel Beauperthuy; Benjamin Franklin, Inventor of Bifocal Spectacles; McCrae, William and John Hunter; Toomey, Richard Blackmore; Shipley, Treatment of Convulsions (Tetany) with Calcium in the 17th Century; Leake, Kappa Lambda; Dock, Robert Talbor, Madame de Sévigné, and Cinchona; Ingle, Regulating Physicians in Colonial Virginia; Chance, English Worthies of Science of Interest to Ophthalmologists; Krumbhaar, Early History of Anatomy in the U. S.; Dock, Early Observers of Albuminuria; Coriat, Medical Magic; Wilson, Caduceus, Its Symbolism; Riddell, George Cheyne and the "English Malady"; Wickersheimer, "Liber de Medicinis Expertis" Attributed to Galen; Dana, Medicine and the Humanities; Davidson, William Heberden; Charlton, Christopher [illegible]; Cumston, "Paedotrophia," by Sainte-Marthe.

Published by PAUL B. HOEBER, Inc., 76 FIFTH AVENUE, NEW YORK, N. Y.